SCIENCE TODAY AND TOMORROW

Discovering with Science

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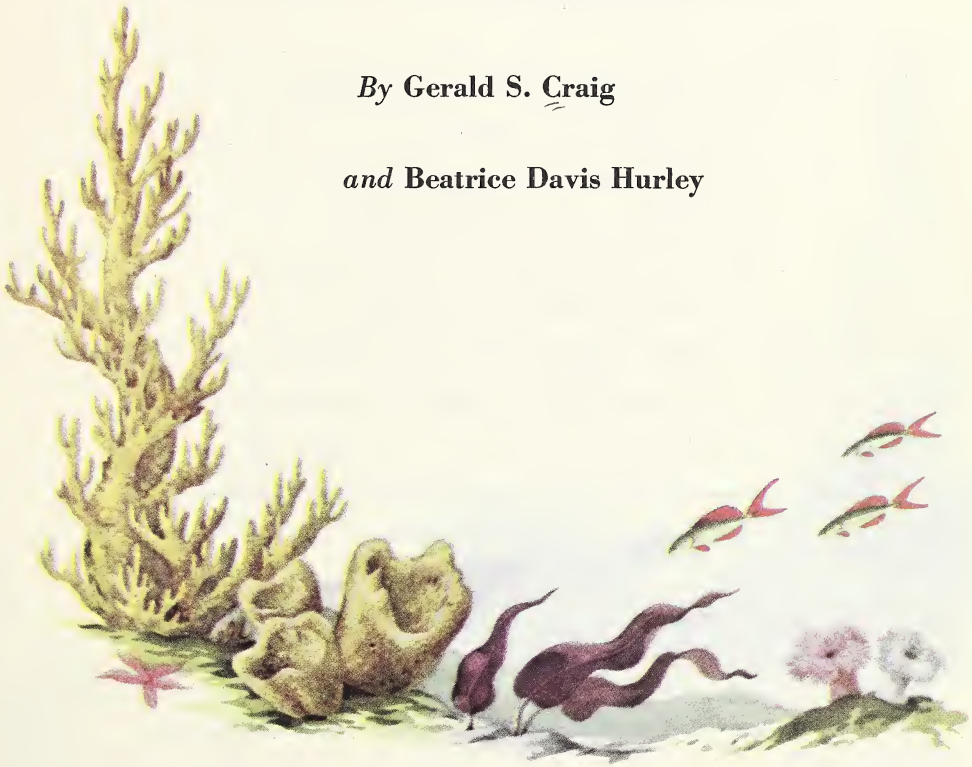
Discovering with Science

By **Gerald S. Craig**

and **Beatrice Davis Hurley**



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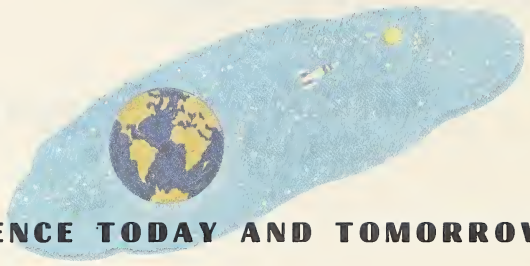

SCIENCE TODAY AND TOMORROW

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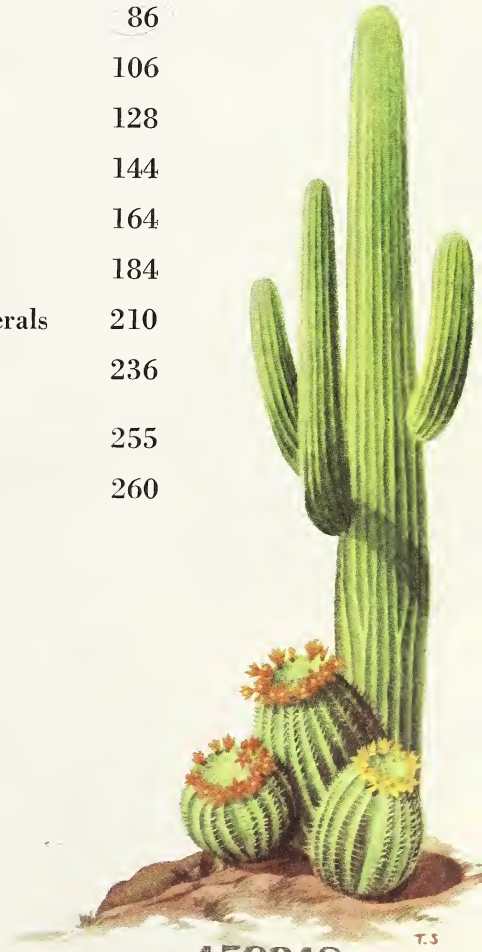

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The Seasons

Back to School

September days are here again. You are back at school. It is good to see all your friends once more. You will enjoy working and playing together again this year.

Yes, September is the month when many boys and girls all over North America go back to school. It is also the month when the fall season begins in North America. September 23 is the first day of fall. Wherever you live in North America, the last days of September, all of October and November, and the first part of December are the months of your fall season.

Are there four seasons where you live? Does winter follow fall? Does spring follow winter? Does summer follow spring? Let's find out about the earth and its seasons.

Heat and the Seasons

You probably live in a place that has four seasons. But the kinds of weather during each season where you live may be quite different from the kinds of weather during each of the seasons in other places.

You may live in a place where summer and winter temperatures are much alike. Or you may live in a place where summer and winter temperatures are very, very different.

If you live in the northern part of the United States or in Canada, you live where there is a great difference between summer and winter weather.

Summer days are usually warm or hot in the northern part of the United States and in Canada. Winter days are usually cool or cold.

You may live in the southern part of the United States or in Mexico. There the summer and winter days are different, too. But most winter days there are likely to be warmer than any winter day in Canada. Most summer days are likely to be hotter than any summer day in Canada.

How does the weather change through the seasons where you live? Are most of your winter days cool or cold? Are most of your summer days warm or hot?

Summer in Canada

Winter in Canada

Finding Out about Summer and Winter Days

Perhaps you are ready now to try to answer this question: Why are summer and winter days in some parts of North America warmer than in others? If you have a globe in your classroom, it will help you to find the answer to the question. If you do not have a globe, the map on this page will help you.

First of all, find the place where you live on the globe or map. Now find the north pole. Is the north pole a long, long distance from where you live? Next find the equator. The equator is an imaginary line making a circle around the middle of the globe. Is the equator a long, long distance from where you live? Your teacher will help you to find these places if you need help.

Ask yourself this question: Is the place where I live nearer the north pole than the equator? This is an important question. It makes a difference in the kinds of weather you have during your four seasons.

If you live near the equator, your summer season is hotter and your winter season is warmer than summer and winter seasons farther north. On the other hand, if you live near the north pole, your summer season is cooler and your winter season colder than summer and winter seasons farther south.

Winter in different parts of the world

Finding Out about Straight and Slanting Rays

The nearer you live to the equator, the straighter the sun's rays shine on your part of the earth. The farther you live away from the equator, the more slanting are the sun's rays. You can understand about straight and slanting rays by doing the following experiment in your classroom:

Hold a flashlight in your hand so that its light shines straight down on the floor. Have someone draw a circle on the floor where the light falls. Draw the circle lightly with chalk, so that it will wash off easily. You will notice that not much of the floor is lighted, but that the light is bright on the floor.

Now tip the flashlight so that the light hits the floor at an angle. Again have someone draw a line around the lighted part of the floor. You will notice that this lighted part of the floor is larger, but that it is not so bright as before.

Try the experiment over again. Have someone hold his hand near the floor each time as the light shines on it. Ask him which time the light warms his hand more.

The sun's rays shine on the earth in much the same way that the light from the flashlight shines on the floor. The slanting rays of the sun spread out over more space as they hit the earth, just as the slanting rays of the flashlight do as they shine on the floor. The slanting rays of the sun heat and light a larger part of the earth, but this part is not heated or lighted so well.

Straight rays shine on a small space

Slanting rays spread out over a larger space

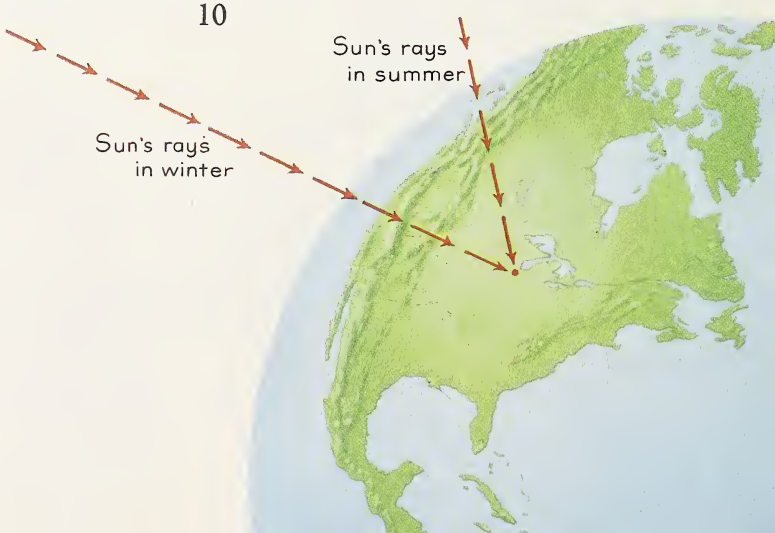
On the other hand, the straight rays of the sun shine on a smaller space as they hit the earth, just as your flashlight rays do when you hold the flashlight straight. They heat and light this space better.

The closer you live to the equator, the straighter are the sun's rays that shine there. This is one reason why places near the equator are warm or hot. Places far away from the equator are cool or cold because the sun's rays that shine there are more slanting.

At some times of the year the sun's rays slant more than at others. Wherever you live in North America, your winter season is cooler than your summer season. Perhaps the warmest day during the summer was 100 degrees where you live. Your warmest winter day will not be that warm.

One reason for this is that in winter the rays of the sun that shine on your part of North America are more slanting than they are in summer.

Summer and winter may be thought of as seasons of hotness and coldness. They may also be thought of as times of the year when the sun's rays are straighter or more slanting.



Summer Days Are Not All Alike

Suppose your class takes an imaginary trip right now. Let's make believe you live in Mexico and that you are going to visit the city of Vancouver in Canada. Your trip will take you through the northern part of the United States and into southern Canada. It is June, and the weather is hot. The temperature on the day you are packing for your trip is 92 degrees.

What a hot day it is to pack! You keep on putting summer clothing into your bag. You can hardly believe that you will need any warm clothes. But you'd better look at that globe or map again before you close your suitcases.

Where is Canada? In what direction shall you be traveling? Shall you be going away from the equator or toward it? Remember what you have just been reading. Will the sun's rays that shine on Vancouver be more slanting than those that shine on Mexico?

Of course you know by now that you'd better pack a sweater and perhaps a coat too. You'll be sure to need them on some days as you travel north.

What fun you have on your trip! You travel by way of California, past orange groves there. You admire the tall evergreen trees in Oregon and Washington. Finally, you arrive in Vancouver, Canada.

It has taken you about two weeks to reach Vancouver by car. It is still June. Yet already you have used both your sweater and your coat. You are glad that you brought them along, for there were a few days when you needed them to keep you warm.

Let's look again at the globe or map. Have your teacher help you to find Vancouver. Is it north of Mexico? Is it nearer the north pole than the equator?

You remain in Canada for a month. The weather there is comfortable. Many days are warm and sunny. It is often warm enough to enjoy a swim and to wear summer clothing. But even in summer the sun's rays are slanting rays in Vancouver. It is cool enough to need a sweater sometimes, too.

Letters from home tell you how hot it is in the part of Mexico where you live. There the sun's rays shine straighter. It is very hot there during the summer season.

Winter Days Are Not All Alike

Now suppose you live in Montreal instead of Mexico. Can you find this city on the globe or map? If you need help, ask your teacher to help you. What about straight and slanting rays there?

It is December in Montreal. The winter season begins there on December 22 and lasts for three months. You are in school, so you cannot take a vacation. But you don't care, because you like winter in Montreal.

The days are cold. After school you hurry home to get your skates. Away you go to the pond! You glide and turn as you skate over the smooth ice. Skating is great fun on cold winter days.

On Saturday you bundle up in warm clothing. You pull your ear flaps down over your ears and put on warm, furry mittens. You are off with your sled for a ride.

The air is clear and cold. You stay outdoors for an hour or so. Then you decide to go indoors and warm yourself. Winter days are cold in Montreal. Winter days there are colder than winter days farther south.

Take Washington, D.C., for example. The children there also may have a chance to skate and to go sliding in winter. They bundle up in warm clothes. Children in Washington think of their winter as being cold. And many days are.

Winter in Montreal

But many winter days in Washington are warmer than most winter days in Montreal. There are many more days for skating and sliding in Montreal than in Washington each winter.

Again, if you look at your globe or map, you will know why this is true. The winter rays of the sun that shine on Washington are less slanting than those that shine on Montreal.

Now suppose you live in New Orleans, Louisiana. What are the days like there in winter? Well, first of all most winter days there are warmer than winter days farther north. They are warmer than most winter days in Montreal or in Washington.

The children in New Orleans think of their winter days as cool. And compared with their summer days, they are cool. The children feel the difference between winter and summer days. Sometimes on a winter day in New Orleans it may freeze or even snow. But most winter days in New Orleans do not get that cold.

In New Orleans there are not many days when you could use a red sled or a pair of skates, even if you owned them.

Can you find New Orleans on your globe or map? Is it nearer the equator than it is to the north pole? Can you tell now why winters in New Orleans are warmer than winters in Washington?

Winter in New Orleans

Finding Out about Long and Short Days

Of course you already know that a day and a night are twenty-four hours long. You know, too, that during the summer season in North America days are longer than nights.

Think for a moment, and you will remember that this is true. In the summertime do you often play outdoors after supper? You may jump rope or play baseball or some other game. Perhaps it is light enough to play outdoors until as late as eight-thirty or nine o'clock where you live.

What about winter days where you live? Is it often dark when you eat your supper? You cannot go outdoors to play games after supper. You must play indoors instead.

If you lived right at the equator, there would not be such a difference. Days and nights are almost always of equal length there. Each day is about twelve hours long. Each night is about the same length.

As you travel north from the equator, days and nights are not equal in length. Summer days are long, and winter days are short. The sun rises earlier in summer in North America than it does in winter. The sun sets later in summer in North America than it does in winter.

Do you sometimes have a hard time getting up in the winter? Perhaps you open one eye, and everything is dark outside. You can't believe it is seven o'clock and time to get ready for breakfast. So you shut your eyes and go back to sleep.

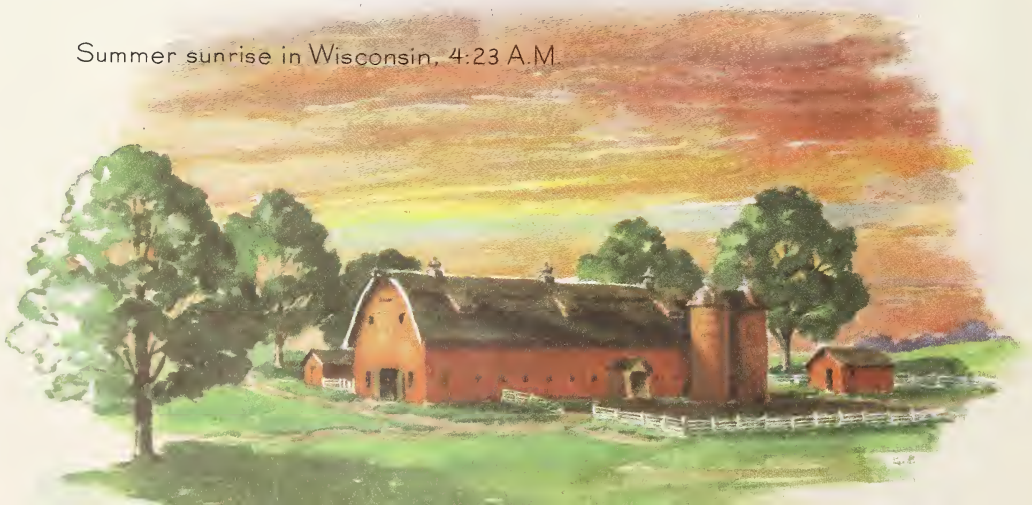
The sun rises later in winter in North America than it does in summer. Is it often still dark at seven o'clock in the morning in winter where you live?

The time of day the sun rises and sets is one reason why days are colder and warmer during the different seasons.

As you know, the earth gets its heat from the sun. The longer the sun shines on any part of the earth, the more hours it has to heat that place. There are more hours of sunshine each day in summer in North America. So there is more heat.

In winter in North America there are fewer hours of sunshine each day, and there is therefore less heat.

Remember this also: no matter where you live in North America, you receive straighter rays of the sun in summer than in winter. Remember that straighter rays mean more heat.



Summer sunrise in Wisconsin, 4:23 A.M.

Winter sunrise in Wisconsin, 7:26 A.M.

If you live in the northern part of the United States or in Canada, you know that there is a great deal of difference between the length of days in summer and the length in winter.

If you live in the southern part of the United States or in Mexico, there is not so much difference between the length of your day and night in summer and the length in winter. Even so, days there are longer than nights in the summer and shorter than nights in the winter.

Use your globe or map again. You can now compare the length of days and nights where you live with the length of days and nights in places north and south of you.

Plan to keep a record of the time the sun rises and sets each day where you live. Keep your record for at least a month. In this way you can see whether the days are getting longer or shorter during this time of year.

You may be able to find out from your daily newspaper the time that the sun rises and sets. You may also ask the nearest weather station to help you to get the time the sun rises and sets each day in your neighborhood.

After your record is finished, it might be fun to find out how much the amount of sunlight in your neighborhood changed during the month. Did you find that there were more minutes of sunlight at the end of the month, or were there fewer minutes of sunlight?

South of the Equator

You have been reading about seasons in the continent of North America. The winter season begins here on December 22. The first day of spring is March 21. Summer starts on June 22, and autumn begins on September 23.

For children who live south of the equator the opposite is true. Find South America on your globe or map. Notice that most of this continent is south of the equator. While you are having summer where you live, children in most of South America are having winter. While you are having spring, children there are having fall.

Yes, if you lived south of the equator, the months of each season would be different. Something else would be different, too. As you travel south, away from the equator, winters would be colder and summers cooler.

You might keep on going south and finally reach the south pole. Winters there are very, very cold. Summers there are very cool, just as they are near the north pole.

As you grow older, you will learn more about the earth and its seasons. Now you have learned three reasons why the seasons change. Perhaps you will remember these three ideas better if you think of them in the following way:

1. The distance that you are away from the equator affects the kinds of seasons you have where you live.

2. The way that the sun's rays hit your part of the earth affects the kinds of seasons you have where you live.

3. The difference between the length of night and the length of day affects the kinds of seasons you have where you live.

1. Really your globe is a very important instrument when you are learning to understand the seasons. If you have been using it, you know that this is true. You may wish to study it some more. You might like to find places that members of your class have visited. Let each person who has visited one of these places describe the kind of weather there. See if you can explain why the weather there is as it is. Ask yourselves these questions:

How far is this place from the equator?

At what time of year was this place visited? At this time of year, would the days be longer or shorter than the nights?

Would the rays of the sun that strike this place be straight or slanting?

2. If you lived in Australia, what months would be your winter season? What ones would be your summer season?

3. Have you ever heard of the Land of the Midnight Sun? Try to find out where this place is. See if you can find any reason why the sun would shine at midnight there. Your globe will help you again.

Suppose you place a flashlight on one end of the table where your globe stands. Can you place some books under the flashlight so that the part of the earth near the north pole is lighted even at night? This is summer at the north pole. Now can you change the position of the flashlight so that the north-pole area is dark even at noon? This is winter at the north pole. In summer at the north pole the sun shines day and night for almost six weeks. In winter at the north pole the sun does not shine at all for about six weeks.

4. Suppose that you wanted to be in South America during its summer season. When would you plan to go?

5. Think about how the seasons affect you. Write a short story telling some of the things you do in the summer season and some you do in winter.

Animals and the Seasons

Animals Change Their Ways

As the seasons change in your neighborhood, animal life changes, too. During the warm summer months there is much food for animals. Animals are busy eating and growing. Some of them eat more food than they need. This food is stored as fat.

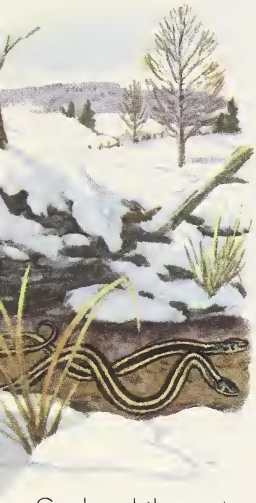
As cooler days arrive, many birds fly to warmer places. Other animals bury themselves in the ground and spend the winter there. Still others find shelter in hollow logs or caves or old buildings.

As spring and summer days come again, insects can be seen almost everywhere. Many birds return from the south. Animals climb the mountains and graze. Fish seek shallow waters and raise their young.

Some Animals Hibernate All Winter

Did you ever wonder where toads and snakes and turtles and frogs go when cold winter days come?

These animals find places that are protected from the icy wind and crawl into them. They may bury themselves in the mud or sand at the side of a pond.



Snakes hibernate

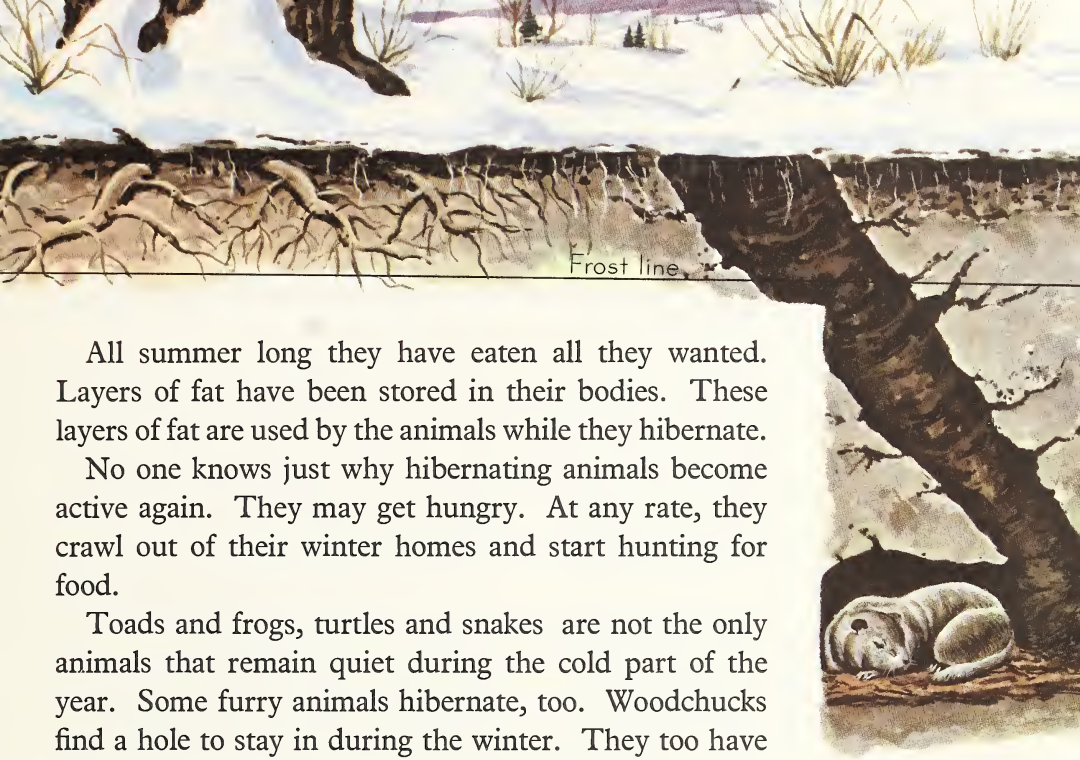
We say that these animals hibernate, or seem to sleep. That is, they become quiet much as you do when you go to sleep. They have been active all summer and fall. Now they seem to sleep.

But really their quiet time isn't like our sleep. While they hibernate, the work that goes on in their bodies almost stops. They breathe ever so slowly. You might even think that the animals were dead. But they are still alive.

Snakes crawl under rocks and boards and old logs to hibernate. Here they are safe and warm while the cold winds blow.

You may wonder who brings them their food. No one needs to bring food to these hibernating animals. They do not need to eat during their quiet time.

Turtles and frogs hibernate



Woodchuck
in its winter home

All summer long they have eaten all they wanted. Layers of fat have been stored in their bodies. These layers of fat are used by the animals while they hibernate.

No one knows just why hibernating animals become active again. They may get hungry. At any rate, they crawl out of their winter homes and start hunting for food.

Toads and frogs, turtles and snakes are not the only animals that remain quiet during the cold part of the year. Some furry animals hibernate, too. Woodchucks find a hole to stay in during the winter. They too have layers of fat which they use as they hibernate.

The picture on this page shows you why woodchucks hibernate in deep holes. Can you see why they would not hibernate near the top of the ground? Would they be comfortable near the top of the ground?

When woodchucks start hibernating, they are round and fat. You should see them at the end of their long quiet time. They have grown very thin. Some of the fat in their bodies has been used as food. How hungry they must be when they wake up!

You may live in a part of the world where winter is not a cold time. Frogs, toads, turtles, and snakes that live in warm places do not hibernate. They stay active almost all the year through.

Some Animals Hibernate Part of the Winter

Many animals hibernate only part of the winter. This is true of chipmunks.

During most of the year chipmunks hunt nuts and seeds for food. How busy they are! You can watch them eating. You can also see them carrying nuts and seeds to safe hiding places in underground tunnels.

As the cold days come, chipmunks crawl into their underground homes and curl up. They seem to be sleeping. But they are only quiet. They are hibernating.

From time to time during the winter they wake up. If they are hungry, they have a little feast of nuts. They may even run about hunting for more food. Then they become quiet again.

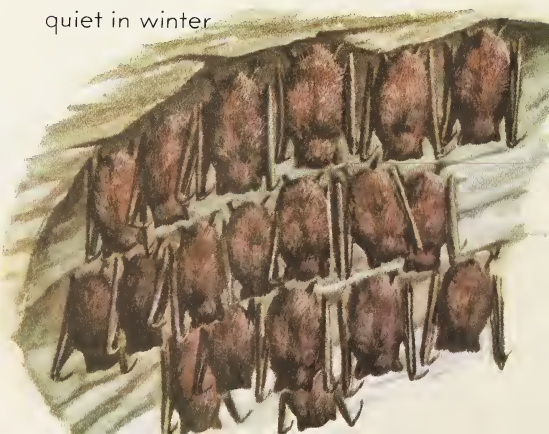
Many other animals hibernate for only part of the winter. Some bats keep going to sleep and waking up all winter long. When they wake up, they usually go out to look for food.

Meadow mice and squirrels hibernate during part of the winter, too. Perhaps you have been surprised to find them running about in winter.

When you see them out on cold winter days, you know they are hunting for a little bite to eat. Then they go back to sleep again.

Some kinds of bears hibernate part of the winter. They crawl into a hole or cave, where they keep warm. They wake up and go back to sleep several times during the cold weather.

Chipmunk's winter home



Bats become quiet in winter

Wild geese

Some Animals Travel Long Distances

"Honk, honk, honk!" There they go, flying high above in the shape of a V. Not airplanes! Wild geese! They are flying north. Can you guess what season of the year it is?

Wild geese and many other animals take long journeys in the fall and spring. We say they migrate. They travel south in the fall and north in the spring.

Do you live in a place where there are many cold winter days? If so, you may wish for the return of the birds to your schoolyard. Are robins among the first birds to return to your part of the country?

Bluebird

Sometimes robins arrive too early and are caught in the last snowstorm of the year. If that happens, they may need your help. You may have to feed them.

You are glad to do so. You know that the return of the robins and other birds means "Spring's here at last!" Soon you will be jumping rope or playing baseball again.

Song sparrow

Many, many birds fly north as the warm days come. They fly and fly. Finally, they find a place to build their summer homes. Do some of these birds that fly north build their nests near your home?

Hungry young robins

How busy robins are once they arrive! We see them carrying many things in their mouths. They use small bits of string, paper, leaves, feathers, and other things to build their nests. We know that eggs will soon be laid in these soft, round nests.

Day after day the mother bird sits on the eggs and keeps them warm. The male bird sometimes brings food to her. Some male birds sit on or near the nest while the female bird goes for food.

Before many days fuzzy heads stick up above the top of the nest. What a noise! Here come the grown-up birds with food for the hungry, growing ones. No wonder the young birds grow fast. They eat so much.

Some birds stay in the same place the year round. They do not migrate as the seasons pass. They live in the same region all winter and all summer.

You may be surprised to know that some birds are great travelers. Many birds build their summer homes miles and miles away from where they live in winter.

The golden plover is one of these birds. This bird builds its summer home in the northern part of North America. It spends the winter in South America.

Twice each year the golden plover flies miles and miles to get from its summer to its winter home and back again.

Arctic terns are great travelers, too. Twice each year they travel about 11,000 miles to reach their summer and winter homes. Their nests have been found in the northern part of Canada. But their winter homes are thousands of miles to the south.

As Birds Migrate

Birds meet many dangers as they migrate. They sometimes have to fly through heavy storms. They may run into ice and snow as they fly north. They may have to fly against a strong wind. Sometimes the wind blows them far out to sea, and they become tired and fall into the water and drown.

Each year many birds die because of bad weather. Often they bump into trees or high buildings or lighthouses. Lights may attract them toward the buildings. In the morning many birds may be found dead near these places.

Sometimes, on the other hand, the wind helps the birds on their long trips. We might say the birds ride on the wind when it is blowing their way.

Most birds stop to feed and to rest along the way as they migrate. Some travel only a few miles in a day. Others travel much farther.

Have you ever seen birds getting ready to migrate? They gather in large flocks. That is the way they travel. They go north and south in flocks.

The larger birds usually travel by day. They rest and find food on the way. The smaller birds usually travel at night. They are safer from larger birds when they travel at night.

You must have seen migrating birds resting on their long journeys. Sometimes hundreds of them will light on telephone and other wires. You may have frightened them away as you rode past in your car.

Herring gull

Canvasback duck

Chimney swift

Some birds which migrate

Long-billed curlew

No one really knows just *why* birds migrate. Different people have different ideas about that.

Some people believe that birds migrate to get food. Yet this could hardly be the only reason. Many birds begin their journeys while there is still much food where they are.

Besides this, birds would not need to fly as far south as many of them do to get food. They could stay much nearer their summer homes in the north. There would be enough food for them to eat.

Robin

Some other people think that birds may migrate because of habit. Long ago birds may all have lived in warm places. The food supply may have become scarce, and some birds may have traveled north in search of food. Each year they may fly north because they have formed the habit of doing so.

Tell your classmates any ideas you have about why birds migrate in the spring and fall. After all, no one really knows just why. Your idea may prove to be the right answer to this question.

Arctic tern

Some Other Animals Migrate, Too

Birds are not the only animals that migrate as the seasons come and go. But birds migrate in greater numbers than any other animals do. Perhaps they are better suited to migrating because they can travel so fast.

A few other animals do migrate, however. Alaska fur seals travel to the cold waters of the Bering Sea. Here they raise their young. As colder days arrive, both young and old swim farther south to warmer water. Here they stay until the next spring.

Polar bears migrate, too. They live on large pieces of floating ice in summer. Here they mate and have their young. The ice travels to the south in the summer and fall. The bear families float along on it. As the winter days arrive, the small pieces of ice freeze together. Then the polar bears travel north again over the solid ice.

Some fish migrate also. Salmon that live in the Pacific Ocean are great travelers. The grown salmon travel from the salty ocean waters to the fresh waters of rivers. Here they lay their eggs.

This trip upstream is a very hard one. The salmon sometimes leap many feet into the air to get over the waterfalls and rapids in the rivers. They travel only a few miles a day because they have to swim against the swift water.

Finally, they reach the places where the rivers are not so swift. Here they lay their eggs. They then float down toward the ocean again. But they do not ever reach it. They die on the way.

When the young salmon are 2 to 5 inches long, they swim down the rivers to the ocean. They stay in the ocean for several years before they migrate up the rivers to fresh water again.

Animals Change in Other Ways

You have been reading about animals that hibernate or migrate as the seasons pass. Many animals do neither of these two things. They stay in one place during all four seasons. But they change with the seasons.

Dogs and cats stay in one place the year round. They grow a thicker coat of hair in winter. This thick coat keeps them warm. In summer they lose some of their coat. Hair drops out of their coats.

Sheep grow thick, woolly coats, which keep them warm during the cold winter days. In the spring the farmer cuts off this woolly coat. If he did not cut it early in the spring, some of it would drop off. Then the farmer would not have as much wool to sell.

You may have wondered why there are so many duck and chicken feathers around the barnyard in the spring and summer. Ducks and chickens grow more feathers as winter comes. They lose some of their feathers in the spring and summer.

Horses and cows grow thicker coats in winter, too. You may have noticed how long and shaggy their coats are in the early spring. They lose some of the hair in their coats as the warm days come.

Some animals change color as the seasons pass. Perhaps you know that some foxes have a blue-gray coat in summer and a white coat in winter. Their clean, white coats match the clean, white snow. Hunters cannot see them easily.

Horse in winter

Horse in summer

Weasel in summer

Weasel in winter

Weasels change color, too. In summer weasels are brown and white. In winter most weasels are white except for black on the tips of their tails.

Can you see why a white weasel would be safer in winter? Its coat is the same color as the snow. Therefore enemies of the weasel cannot find it so easily.

Do you know of any other animals that change color as the seasons pass? Do any of the birds that live near you look different in spring and in fall?

Are there many insects where you live in the summer? Insects live in many, many places, and there are many of them. Bees, ants, flies, butterflies, and moths are insects. Can you name others that live near you?

All these insects are around in spring and summer. What happens to them when cold weather comes? Many of them die when the days grow cold.

In places where the winters are cold only a few worker bees and the queen remain alive. The queen bee is the bee that lays the eggs.

A queen honeybee may spend the winter with a few worker bees in a hollow tree.

A queen wasp often finds a warm place in an old building and spends the winter there.

Some other insects remain alive all winter in their warm homes. Some spin cocoons for themselves and spend the winter inside them. Others live in warm homes underground.

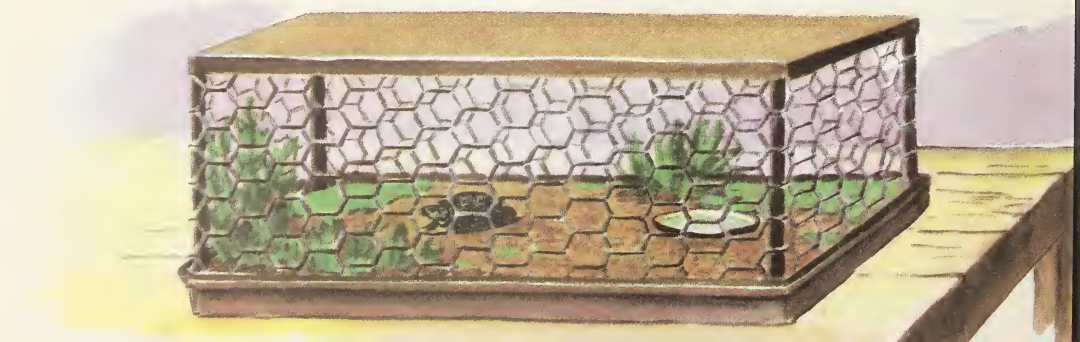
Yes, there are many ways that animals live through the seasons. How do some of the animals in your neighborhood live?

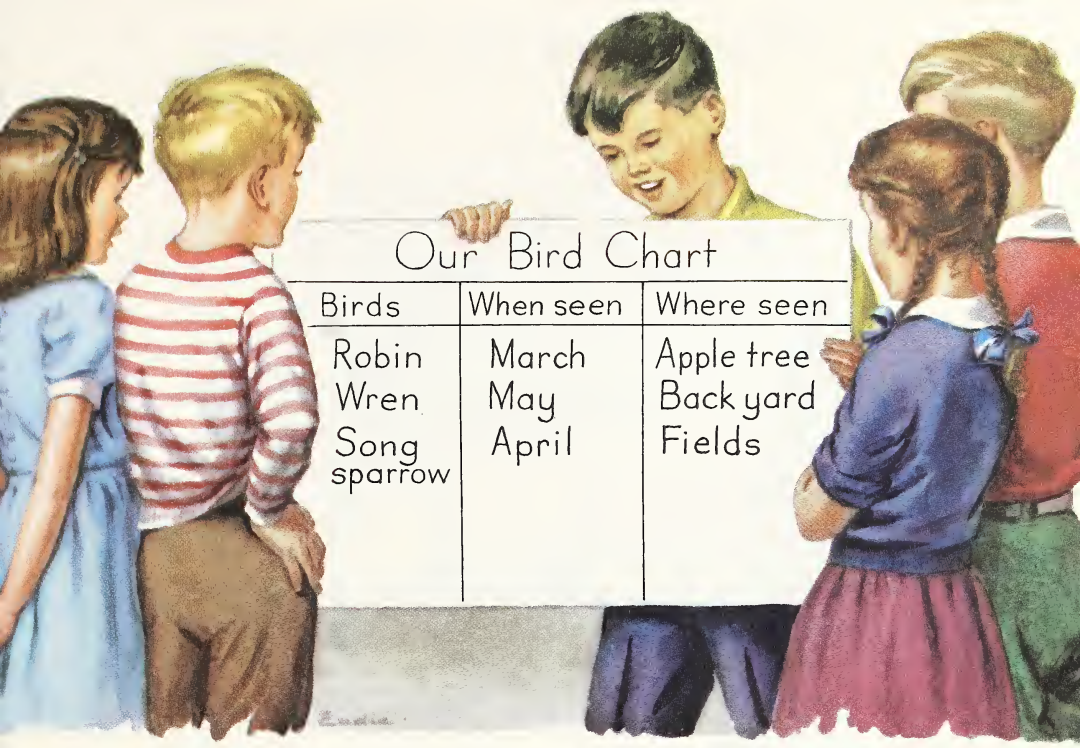
SOME THINGS FOR YOU TO DO

1. No matter where you live in North America, there must be some animals there, too. What animals live near your home? Make a list of them. Now watch these animals as the seasons change. Which ones leave your neighborhood as cold days arrive? Which animals stay active all winter? Can you find out which animals hibernate as cold winter days come?

2. Each member of your class may wish to choose one animal to watch. You might write a diary about the animal you choose to study. Your diary might have four chapters in it. One chapter might tell what your animal does in spring. Other chapters might tell what your animal does in the other seasons. Pictures would make your diary more interesting to others.

3. If you would like to watch an animal that hibernates, you can keep a frog or a small turtle in your classroom. Make a box of wire screen and set it in a metal pan. Put some soil on the bottom of the box. You can grow some plants in the soil. Now put your frog or turtle in the box and keep the box in a cool place. If your coat closet is cool, that will do. Be sure to give the animal food and water. Watch to see what it does in cold weather. Watch what happens on warmer days.





4. It is fun to keep a bird chart like the one above. You may keep it in the spring or in the fall or in both seasons.

5. You or your teacher may know someone living in another part of North America. You might like to exchange letters and learn about animals there.

6. Try to find out about eels. Eels are one of the few fish that migrate from fresh water to salt water to lay their eggs. They live most of their lives in fresh water. When they are full grown, they swim out to sea.

7. If you live in a place where the winter is cold, you will notice many changes in animals. Talk about some of these changes.

Plants and the Seasons

As Seasons Change

You know that you, your mother and father, and others plan for each season as it comes and goes.

You may wear different kinds of clothing as the seasons change. You may play different kinds of games, and your mother may cook different kinds of food. Yes, people do different things as the seasons change.

Plants change, too, with the seasons. They do not plan, as we do. But as each season passes, many of our plants change. Sometimes flowers are in bloom or trees are covered with fruit. At other times branches are bare.

Study the four pictures on these pages and notice how the growing plants change with the seasons.

Plants during the Summer Season

Unless you live at the equator or near it, summer is the warmest season of your year. If you live near the equator, your seasons change very little. It is hot at the equator the year round.

Summer is the season of the year when the greatest amount of sunshine comes to your part of the earth. It is also the season when the rays of the sun that come to you are straighter than at any other time of the year.

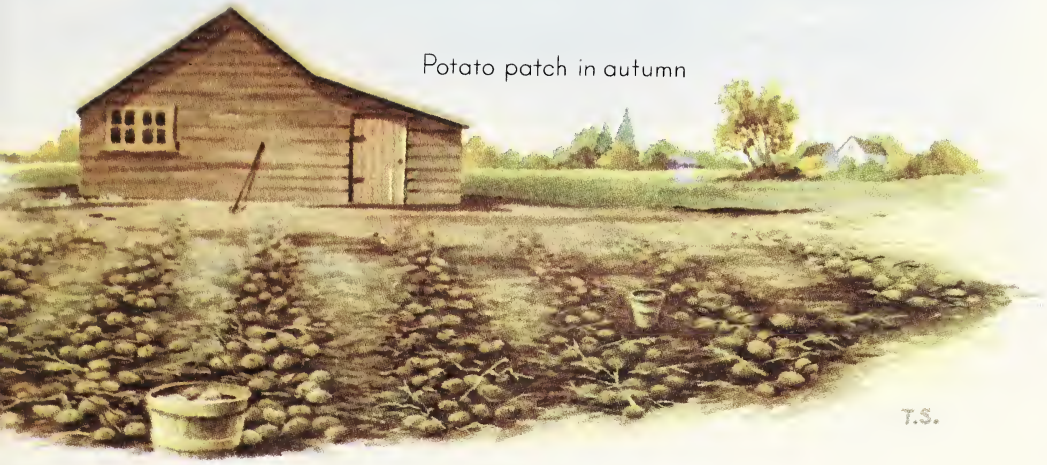
For many places on the earth summer is the time when plants grow very rapidly. They make food as they grow. Some of this food is used by the plants as they grow. Some of it is stored in the plants.

If you have a garden, you know how rapidly plants grow during the summer. You know, too, about some of the ways in which the growing plants store food.

Perhaps you have had white potatoes growing in your garden. Their stems and leaves grow large and spread out over the top of the ground. As the summer passes, the ground may crack around each plant.

It is fun to dig into the ground under the cracks and find the potatoes. The potato plants have been storing food in this way all summer. The white potato you eat is the underground stem of the potato plant.

Potato patch in summer



Potato patch in autumn

Whenever you eat an onion, you eat food that the onion plant stored during the growing season. The onion plant stores food in the bulb. A bulb is really a stem.

When you eat a dish of rhubarb, you eat the food that the rhubarb plant stored in its stem during its growing season.

Yes, summer is the time of year when plants in many places grow rapidly and store food. This may not be true for every part of your country, however.

Your summer season may be the dry season of the year. Plants must have water, as well as sunshine, in order to grow well. If your summer season does not have enough rain, plants cannot grow well.

Many parts of the southwestern United States are dry in summer. In some of these places farmers have learned how to grow plants, even during dry times. They have learned how to bring water to their land.

Many fields are now watered by irrigation. Water is stored in reservoirs that are made by building dams across streams. The water is carried to the fields in ditches. Then farmers can use the water to make their crops grow well.

You may have seen one of these big dams. Millions of gallons of water are stored in the huge reservoirs above the dams. This water is used to make plants grow where no plants could grow before.

Plants during the Autumn Season

Autumn follows summer. This is the season when the earth and the air are beginning to cool a little. The hours of sunlight that reach you each day are getting fewer, too.

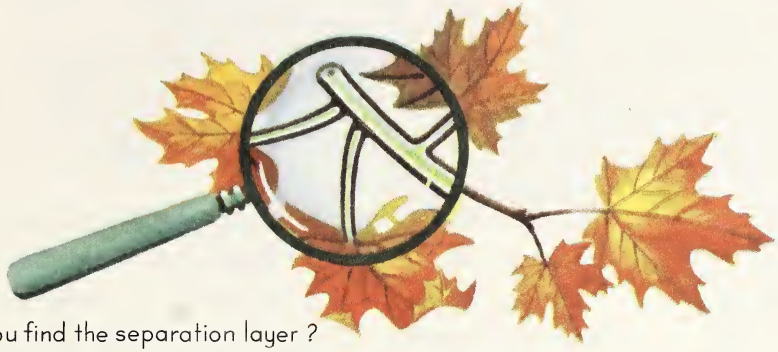
Autumn in many parts of North America is the season when plants of many kinds lose their leaves. You enjoy seeing the beautiful colors of autumn leaves as you walk along the street or ride along a country road.

Before long many of these beautiful leaves blow off the trees. They make a deep carpet upon the ground. As they become dry, they crackle under your feet.

You will want to help your father rake the leaves. These leaves should not be burned. They make good fertilizer for your lawn and garden.

Perhaps you can make a heap of them somewhere in your backyard where they will not blow away. During the winter the leaves will rot in the heap. They will break into little pieces.

In the spring they will be ready to spread over the garden. They should be worked into the soil. In this way they will make your garden a better place for plants to grow.



Can you find the separation layer ?

You may be wondering why the leaves on many trees change color before they drop off. They turn from shades of green to yellow, orange, and red. How beautiful they look! You wish they would stay that way for a long time. But within a short time they drop off and blow away.

During the spring and summer a tree takes water from the soil through its roots. The water passes up the trunk of the tree and into the leaves during food-making time. As summer passes, both food-making and growing slow up and finally stop.

Then the tree forms a thin layer of cork between the stem of each leaf and the twig on which the leaf is growing. This thin layer will prevent the sap from escaping when the leaf falls.

The green color in the leaf now begins to fade. As it fades, other colors that are also in the leaf stand out more clearly. You see red or yellow or orange instead of green.

As soon as the thin layer of cork is formed, leaves fall off easily. Even a gentle breeze blows them from the branches. A leaf that was once fastened tightly to a branch may fall when a raindrop touches it ever so lightly. It falls because of the thin layer that now separates it from its twig.

Not all trees drop their leaves in autumn. The evergreen trees form the tiny layers at any time during the year. So they keep losing some of their leaves throughout the year. For this reason there are always green leaves on evergreens, even in winter.

Perhaps you think of autumn as harvest time where you live. Farmers cut their corn and husk the big, ripe ears. They may also dig potatoes and put them into bags or crates for market.

If you have a garden, autumn may be harvest time there too. Pumpkins are large and round and orange. They are ready to be picked and made into pies. Beets and carrots and onions are pulled up and stored in a dry, cool place for winter use.

The leaves of some of the plants that grow in your garden have changed, too. All summer they were green. Now they are getting brown and dry. Many of them have already fallen off and blown away. Your garden looks very different in autumn.

Of course not all places are alike in autumn. You may live near enough to the equator so that plants keep on growing in autumn and winter too. You may even plant some new crops in autumn. But autumn in many places is harvest time for crops.

Plants during the Winter Season

Winter in many places is the season when plants rest. Many plants appear to be dead during the winter. But some of them are not dead. They are only resting.

As you look out of your window in winter, do trees around you appear to be dead? Does the grass look brown? Does snow cover the ground?

Perhaps you live in a place where the winter season is not very cold. It may almost never freeze, even in winter. Many plants may keep growing during your winter season. You may be able to see flowers in bloom almost all winter. The plants can keep on growing because there is no frost to kill them.

Nina spent last winter in southern California. Her home is in New Hampshire. Nina had never been in California before. What a change for her! In December Nina saw many flowers growing out of doors. Poinsettias were blooming in the yard. They were beautiful there. But it seemed strange to Nina that December days were warm. Winter in New Hampshire was not at all like winter in southern California.

Tree in winter

Poinsettias

Plants and the Spring Season

Spring in many places is the season of the year when seeds are planted and plants begin to grow.

Joan lives where spring is a season of much change. There are more hours of sunlight each day. The air and ground are warming up. Joan and her friends play outdoors in the warm sunshine. They like to have spring days come.

Joan's mother and father are busy in the yard. They are digging in the flower beds and getting the ground ready for planting. They will soon plant flower seeds.

How carefully they dig around some plants that are already coming up! These plants have been in the ground all winter. Now, as the sun warms the ground, the plants start growing. Soon there will be lovely flowers in Joan's garden.

The trees around Joan's house are changing, too. Joan becomes interested in the buds that she sees on many twigs. Some of them are leaf buds. Some are flower buds. The buds have been on the twigs all winter. They were formed there last summer.

The buds were formed while the sun shone hot upon them. Joan did not see them there then, because the big leaves hid them.

The pictures on this page show some of the changes Joan saw as the spring days grew warmer. Buds changed to leaves or blossoms. Soon the trees that had been bare all winter were beautiful and green again.

Alan lives nearer the equator. Spring days where Alan lives are much like winter days. Alan has never seen snow. All winter long there has not been even a frost.

Flowers bloom in Alan's garden all winter. In the winter there is fruit on many trees that grow near Alan's home. The grass in Alan's yard stays green, and vegetables keep right on growing, too.

Paul lives in Alaska. Here spring is a very short time. The warm sun melts the frost in the top of the ground. Then the seeds of the arctic poppy can begin to grow.

How fast they grow! The sun shines day and night. There are just a few weeks of spring and summer in Alaska. Arctic poppies and a few other plants grow, blossom, and form seeds in eight weeks.

The only kinds of plants that grow well where Paul lives are those that can grow fast. During the long, long winter the seeds that the plants make stay alive. They may be blown about by the winds and covered with snow. But in the spring and summer they can grow quickly.

What is spring like where you live? What is happening to plants around you?

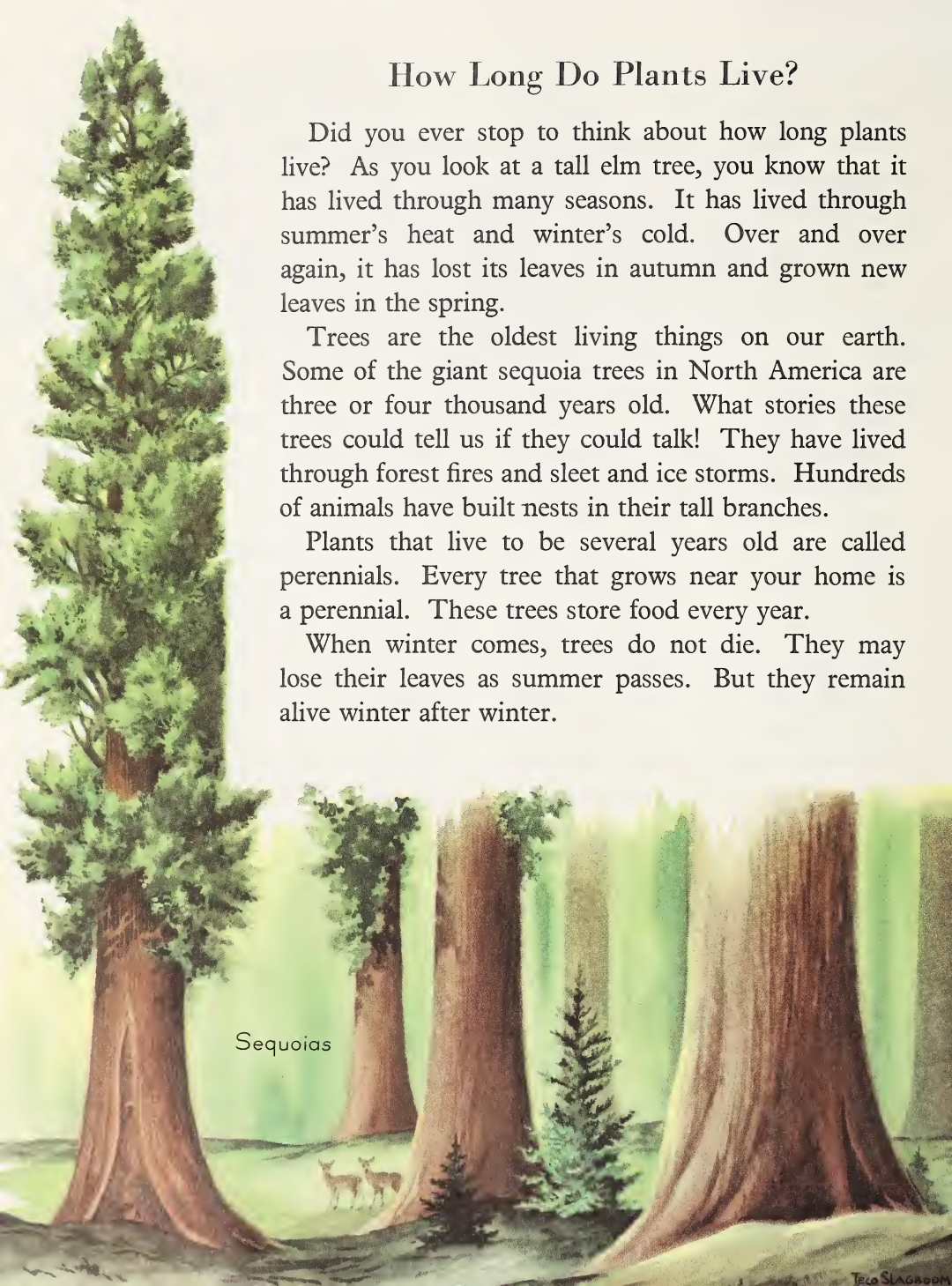
How Long Do Plants Live?

Did you ever stop to think about how long plants live? As you look at a tall elm tree, you know that it has lived through many seasons. It has lived through summer's heat and winter's cold. Over and over again, it has lost its leaves in autumn and grown new leaves in the spring.

Trees are the oldest living things on our earth. Some of the giant sequoia trees in North America are three or four thousand years old. What stories these trees could tell us if they could talk! They have lived through forest fires and sleet and ice storms. Hundreds of animals have built nests in their tall branches.

Plants that live to be several years old are called perennials. Every tree that grows near your home is a perennial. These trees store food every year.

When winter comes, trees do not die. They may lose their leaves as summer passes. But they remain alive winter after winter.



Sequoias

Bayberry

Barberry

Many bushes and shrubs are perennials, too. They may live several years. Do you have any shrubs growing in your schoolyard? Do they lose their leaves in autumn? In the spring and summer do they bloom and form flowers and seeds again?

Some flowers are perennials, also. The dandelion, which blooms in many yards, is a perennial. Its leaves and stems wilt as summer passes, but the roots stay alive all winter underground. As soon as the frost melts in the spring, new stems grow from the roots. Leaves form quickly from these. Before most other flowers are in bloom, yellow dandelions dot the fields and lawns.

Does your mother dig up some garden plants as fall days grow cold? She may put them in pots and bring them indoors, so that they do not freeze. These plants may be perennials, too. If they are, they live during several winters when they are taken indoors. The pictures on this page show you several common perennials. Do any of them grow near your home?

Some plants live only one year. Each year the plants grow from seeds. Each year they grow and blossom and form new seeds. Then they die. These plants are called annuals because they live only one year.

Begonia

Geranium

Ivy

Annuals

Many plants that grow near you are annuals. Corn and beans live only one year. They are annuals. Oats and peas are annuals, too. So are lettuce, cabbage, and tomatoes.

Biennials

Next year annuals will grow from the seeds that formed this year. Your mother may plant some of these seeds in the flower garden around your house. Then you can pick flowers for your dining-room table many times during the summer.

Some plants live two years. These plants are called biennials. The first year they grow from seeds that are planted. They keep growing all that first summer. In the fall their tops die down.

The next spring they start growing again. This time they grow from the roots of last year's plants. The roots have kept alive all winter in the ground. This second year the plants blossom and form seeds.

Some of the vegetables you eat are biennials. Beets and carrots and turnips are biennials. If you did not pull them up and eat them the first year, they would grow again from their roots. During the second year they would form flowers and seeds.

You now know that plants that live only one year are called annuals. Plants that live two years are biennials. And those that live more than two years are perennials.

THINGS TO THINK ABOUT AND DO

1. You may want to plant the seeds of several trees in flowerpots or in a terrarium. Have about 3 inches of sandy soil at the bottom of your pot. A layer of pebbles under the soil is good, too.

Plant several seeds of each kind of tree so that you may be sure that one or two will grow. Tree seeds are harder to grow than flower seeds.

Poplar, maple, and elm seeds grow best if they are planted almost as soon as they fall from the tree. If you are planting acorns or chestnuts, it is best to soak them overnight before you plant them.

Peach, apple, cherry, and pear seeds should not be planted right after you take them from the fruit. It is wise to keep them in damp moss in a cold place for several weeks before you plant them. They will be more likely to grow then.

2. After leaves have fallen from trees, you can easily see the tiny buds on the branches. They were formed during the summer as the trees made and stored food. Watch these buds during the winter months. See if they change any when the first warm days arrive.

3. Plan to watch buds of several trees in the spring. Tie a string around one low branch of each of several kinds of trees that grow nearby. Each day you can look at the branches with the strings on them. You can watch how the branches change. You will see flower buds and leaf buds. Keep a picture record of what you see happening. Draw a picture each day of what you see.

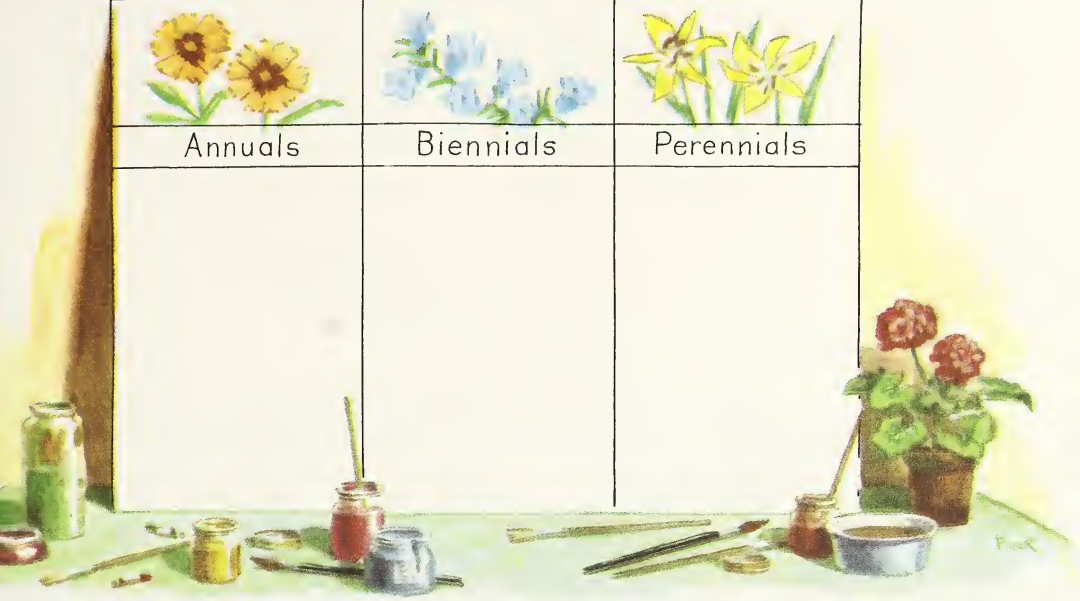
4. Have you ever made a leaf blueprint greeting card? It is fun to do. One or two leaves are all you need. This is the way you make a blueprint:

You can get blueprint paper at a store that sells camera supplies. This is a paper that has been treated so that it changes as light strikes it.

Select one leaf. Place it on a piece of glass. Now put a piece of blueprint paper over the leaf. Next place a stiff piece of cardboard over the blueprint paper. Hold the glass and cardboard tightly at their edges. Go out into the bright sunlight. Hold the glass toward the sun for three to four minutes. The blueprint paper will change color. It will become lighter.

Now go indoors again and remove the glass. Dip the blueprint paper into a pan of clean, cold water. Then lay it on a flat table to dry.

The leaf print will look pretty as the cover of your greeting card.



5. Make a chart of the kinds of plants that grow near your school. Put the names of all annuals in one column, of biennials in another column, and of perennials in another column.

6. Did you ever stop to think about how many, many seeds one annual makes in its short lifetime? Try to count the number of seed pods that one pea plant or bean plant forms. There are several seeds in each pod. Why do you suppose most annuals make more seeds each year than most perennials do?

7. You might wish to make a compost heap of leaves that fall in your schoolyard. Talk it over with the custodian. Find a place where the heap of leaves will be out of the way. Rake the leaves into a pile. In the spring help the custodian spread the rotted leaves over the lawn. In this way you will be helping to make the soil in your yard better.

Where Plants Grow

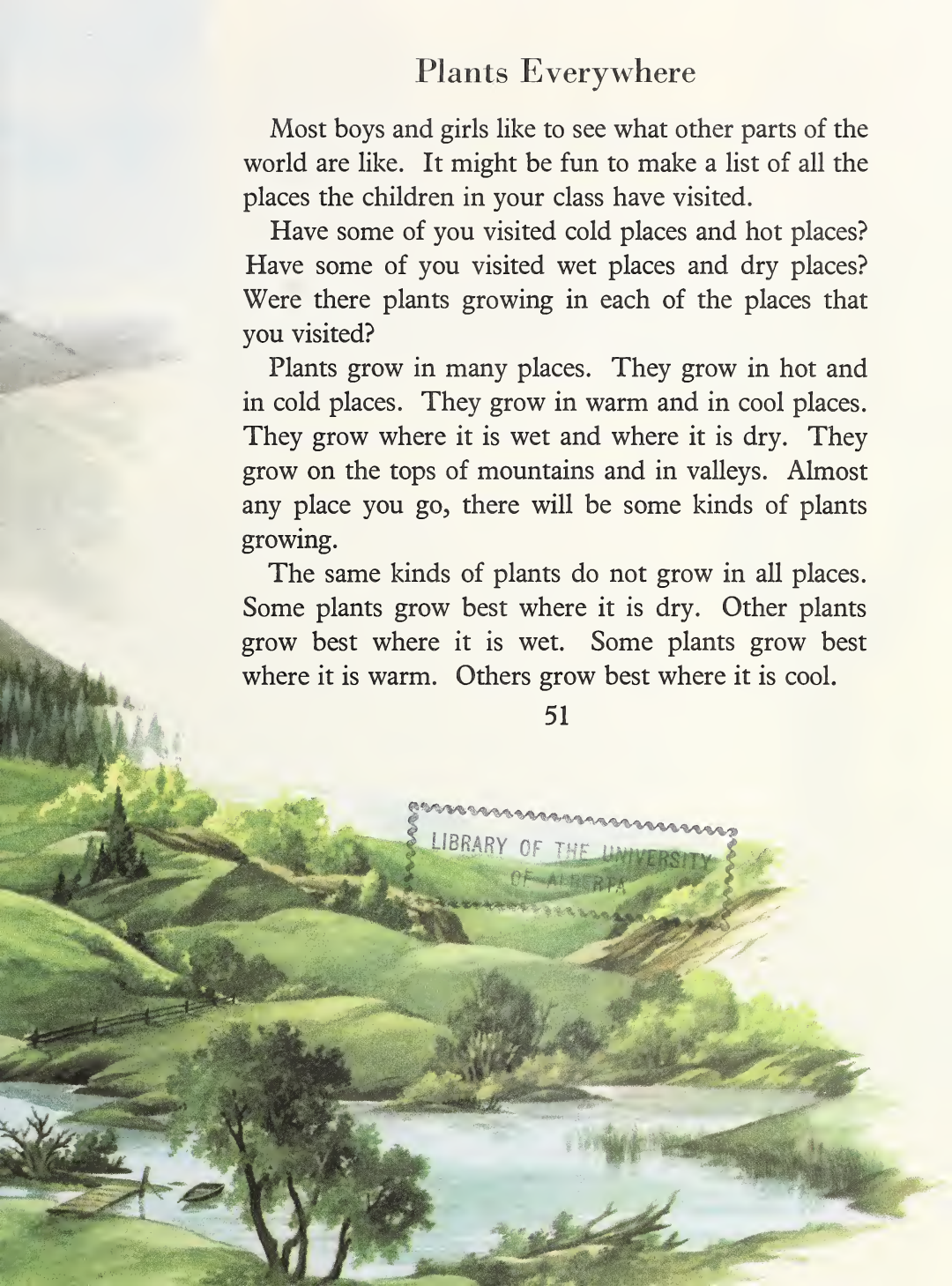
Plants Everywhere

Most boys and girls like to see what other parts of the world are like. It might be fun to make a list of all the places the children in your class have visited.

Have some of you visited cold places and hot places? Have some of you visited wet places and dry places? Were there plants growing in each of the places that you visited?

Plants grow in many places. They grow in hot and in cold places. They grow in warm and in cool places. They grow where it is wet and where it is dry. They grow on the tops of mountains and in valleys. Almost any place you go, there will be some kinds of plants growing.

The same kinds of plants do not grow in all places. Some plants grow best where it is dry. Other plants grow best where it is wet. Some plants grow best where it is warm. Others grow best where it is cool.



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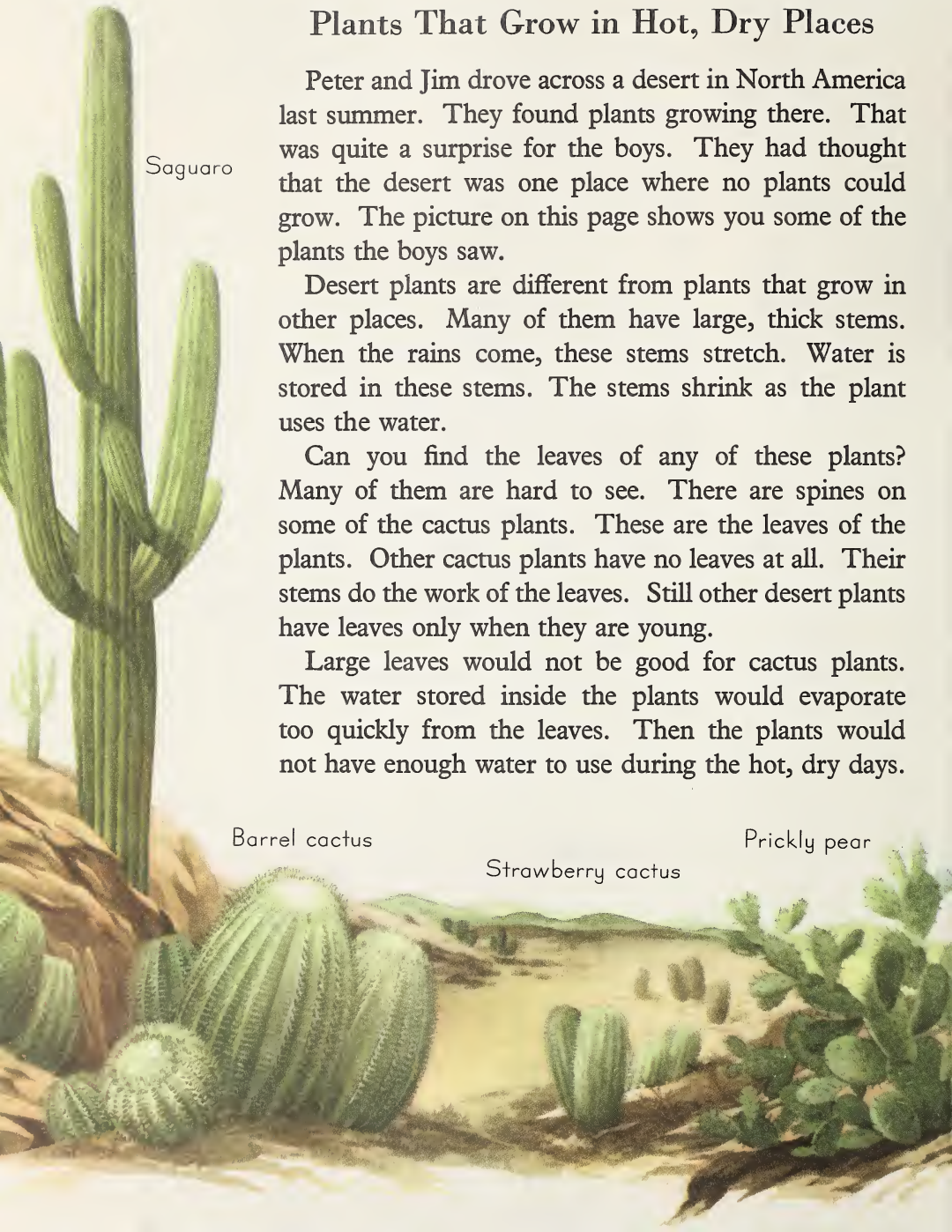
Plants That Grow in Hot, Dry Places

Peter and Jim drove across a desert in North America last summer. They found plants growing there. That was quite a surprise for the boys. They had thought that the desert was one place where no plants could grow. The picture on this page shows you some of the plants the boys saw.

Desert plants are different from plants that grow in other places. Many of them have large, thick stems. When the rains come, these stems stretch. Water is stored in these stems. The stems shrink as the plant uses the water.

Can you find the leaves of any of these plants? Many of them are hard to see. There are spines on some of the cactus plants. These are the leaves of the plants. Other cactus plants have no leaves at all. Their stems do the work of the leaves. Still other desert plants have leaves only when they are young.

Large leaves would not be good for cactus plants. The water stored inside the plants would evaporate too quickly from the leaves. Then the plants would not have enough water to use during the hot, dry days.



Some cactus plants have two kinds of roots. A few other plants do, too. One kind grows down deep into the ground. It soaks up the moisture there. The other kind of root spreads out near the top of the ground. These shallow roots are important when the short, rainy season comes. They can soak up much water in a very short time.

When Peter and Jim crossed the desert, plants were grayish brown and dry. The boys almost thought the plants were dead. Every plant they saw looked about the same color. If they had crossed the desert during the rainy time, they would have seen quite a different sight.

Instead of the dull, gray-brown color that the boys saw, this same desert is colorful when the rainy time comes. Then greenish-white, pink, orange, and other brightly colored flowers may be seen on many desert plants.

Desert plants are able to grow much more quickly than the plants that grow in our vegetable and flower gardens. Only plants that grow quickly can live in the desert. During the long, dry season they keep alive by using water stored in their stems. During the short, rainy season they grow quickly and blossom and form seeds.

Plants That Grow in Hot, Wet Places

Tom took a trip with his father last summer. They went to visit the Amazon jungle in South America. They went up the Amazon River by boat. The picture shows some of the plants they saw growing along the riverbank.

How different these plants look! What large leaves they have! This is a place where it rains almost every day all year long. It is also a very hot place.

Have you ever been in a hothouse during the middle of a summer day? If so, you know that the air inside is hot and very damp. You can even smell the damp, warm earth.

The jungle that Tom visited was hot and damp and full of smells. Tom said, "This place is a steaming jungle." And so it was.

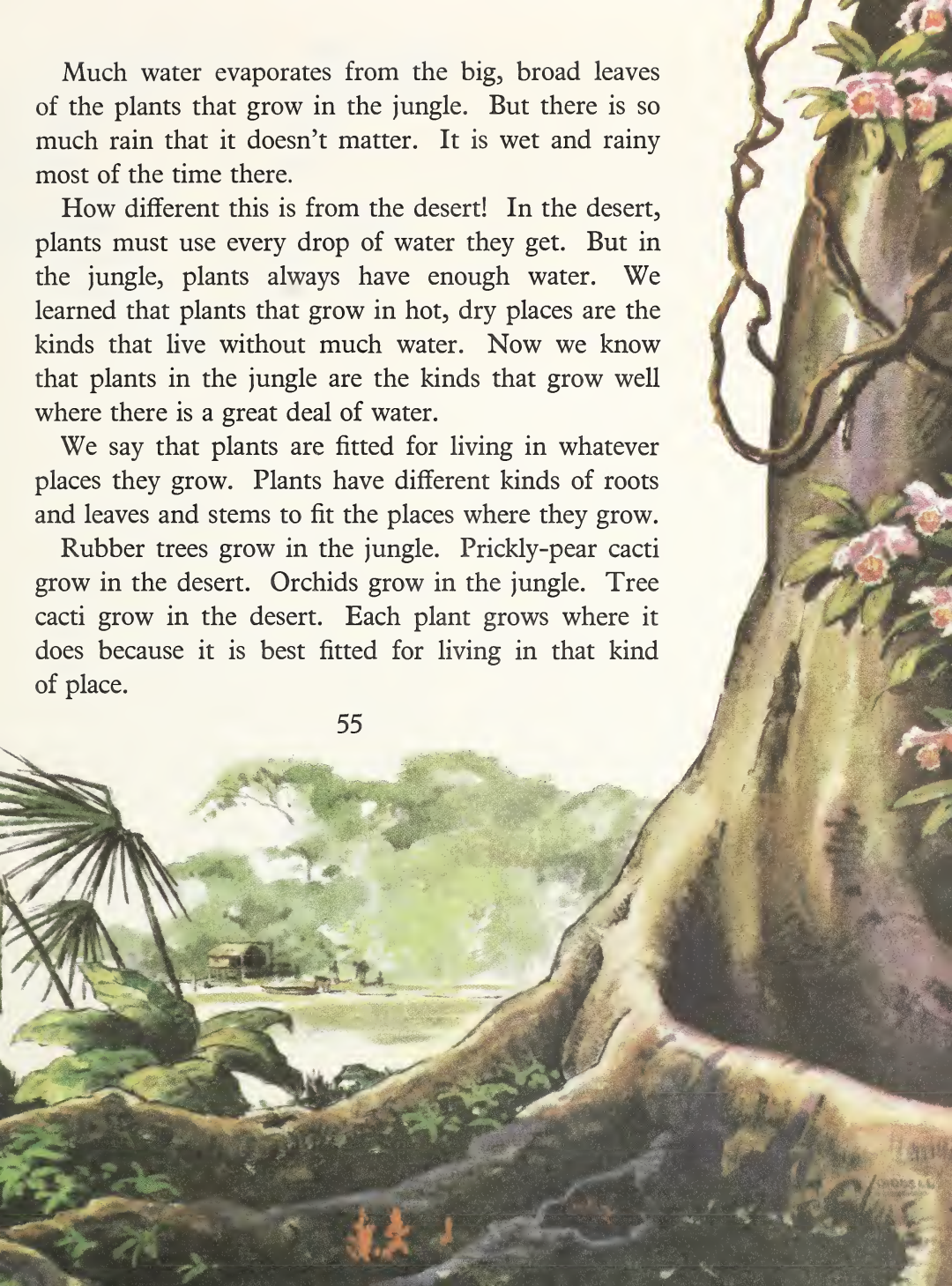
Many of the plants in the hot, wet places grow very large. They grow very close together too. The leaves of many of the plants are broad. They shade one another. The plants grow tall. In this way they get as much sunlight as possible.

Much water evaporates from the big, broad leaves of the plants that grow in the jungle. But there is so much rain that it doesn't matter. It is wet and rainy most of the time there.

How different this is from the desert! In the desert, plants must use every drop of water they get. But in the jungle, plants always have enough water. We learned that plants that grow in hot, dry places are the kinds that live without much water. Now we know that plants in the jungle are the kinds that grow well where there is a great deal of water.

We say that plants are fitted for living in whatever places they grow. Plants have different kinds of roots and leaves and stems to fit the places where they grow.

Rubber trees grow in the jungle. Prickly-pear cacti grow in the desert. Orchids grow in the jungle. Tree cacti grow in the desert. Each plant grows where it does because it is best fitted for living in that kind of place.



Plants That Grow in Warm and Cool Places

Mary and her family took an automobile trip last summer. They drove from the Pacific Ocean to the Atlantic Ocean. From the time they left home until they returned, they had driven over 10,000 miles.

What a fine trip they had! Mary said that there were plants growing everywhere she went. There was no place on the whole trip which had no plants at all.

Mary was right. There are many, many plants growing in the warm and in the cool parts of the earth. Plants that grow in these places are fitted for growing there.

Mary drove east through the northwestern part of North America. There she saw large evergreen forests.

As Mary drove farther east, she saw great fields of wheat and corn.

Mary and her family returned to the west coast by a more southern route. On their return trip they saw many fields of tomatoes, sweet potatoes, peanuts, cotton, rice, and tobacco.

Mary also saw many of the same plants which she had seen growing in other parts of North America. She saw wheat growing in Texas. It was a different kind of wheat from that which she saw growing farther north.

Mary said that she could not begin to list all the plants that she had seen on the trip. She said there were so many that the list would fill the blackboard.

As we learn more about plants, we come to know how wonderful they are. A few can live in very hot places. A few can live in very cold places. Many, many plants can live in warm and in cool places.

Farmers need to know which plants can grow well on their farms. On a farm where there are one hundred and fifty growing days before frost comes, the farmer plants crops that can grow and be harvested within that time.

Another farmer may have to choose crops which have much shorter growing times. He may live where the frost comes sooner.

A farmer in Arizona has a long growing season for his crops. But a farmer in Canada has to choose crops that need a much shorter growing season.

Think again about Mary's trip across North America. Can you explain why she had seen some crops growing in the northern region that she did not see growing in the southern region? Can you tell why she saw plants in the southern region that she hadn't seen in the northern region?

Mary saw some plants that looked similar growing in both regions.

There were apple trees in Canada and apple trees in Texas. But the apple trees were different. The corn Mary saw in Texas was not the same kind of corn that she saw in the north.

There are many kinds of apples, wheat, corn, and other plants. Each kind will grow better in some places than in other places.

Plants That Grow in Cold Places

Micky and his father drove to the top of Pikes Peak in Colorado for part of their vacation. What a trip that was! They made a round trip of 54 miles in order to get to the top and back.

Pikes Peak is not 27 miles high. No mountain on earth is that high. Pikes Peak is only about 3 miles high. But the road has to wind back and forth to reach the top of the mountain.

Micky began to feel cool when he was halfway up Pikes Peak. By the time he and his father reached the top, his teeth were chattering. The thermometer read 25 degrees at 2 P.M.

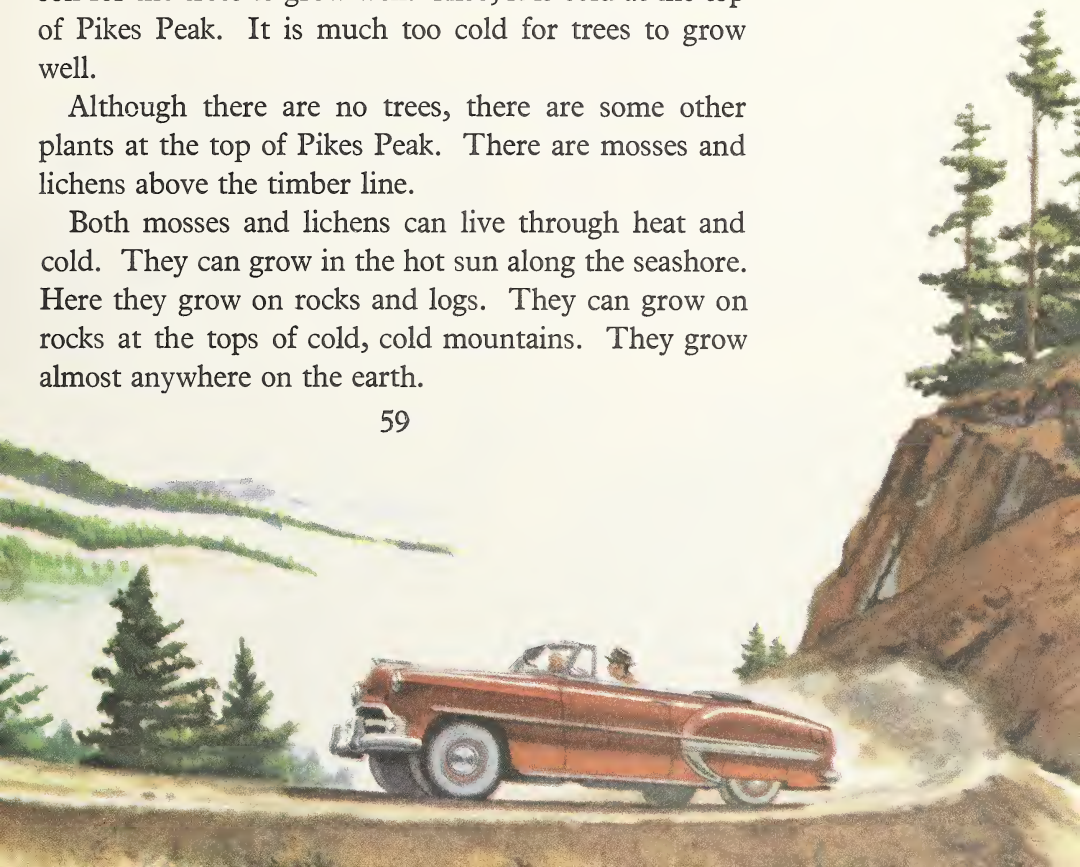
Micky could see snow here and there as they drove along. When they reached the top, his father stopped the car, and Micky made snowballs to throw at his father. Think of it! Snowballs in July!

Micky told the class about the plants he saw on Pikes Peak. There were many evergreen trees growing along the road as they started up the mountain. As they went higher, there were not so many trees. Right up at the very peak there were no trees at all.

The evergreen trees do not grow higher than about 2 miles up the sides of Pikes Peak. We call this point the timber line. Above the timber line Micky saw only bare rock and a few small plants. There is not enough soil for the trees to grow well. Also, it is cold at the top of Pikes Peak. It is much too cold for trees to grow well.

Although there are no trees, there are some other plants at the top of Pikes Peak. There are mosses and lichens above the timber line.

Both mosses and lichens can live through heat and cold. They can grow in the hot sun along the seashore. Here they grow on rocks and logs. They can grow on rocks at the tops of cold, cold mountains. They grow almost anywhere on the earth.



Plants That Grow in Water

There are still other places in which plants can grow. Some plants grow in salt water. These plants are called seaweeds. The picture at the top of the page shows you some of the seaweeds that grow in the ocean.

Tony's family visited Catalina Island on their vacation. They took a trip in a glass-bottomed boat and saw the beautiful undersea gardens. What a sight it was! Tiny plants grew on rocks. Tall, brown seaweed, called kelp, waved about in the salt water. Some of the kelp plants were 100 and more feet tall.

Beautiful blue, green, and orange fish swam about among the large brown leaves of the kelp. They could hide well there.

Plants grow in fresh water too. You may have some fresh-water plants growing in your aquarium at school. The plants that grow in your aquarium or in a fresh-water pond could not grow in the ocean, but they are able to grow well in fresh water.

The white and yellow pond lilies that grow in fresh-water lakes are very common. You often see them when you go fishing.

Most fresh-water plants have very long stems. Sometimes their leaves float at or near the top of the water. They can get more sunshine near the top.

Many kinds of plants grow in marshes and bogs. Some kinds of moss are found in marshes. Cattails grow in wet, marshy places near the shores of ponds. What kinds of plants grow in marshes near your home or schoolhouse?

The plants you see in the pictures on this page are ones you might find growing along the edges of streams and ponds or in bogs and marshes. Each one of them is well suited for growing in such places.

The next time you go walking near a stream or a wet, marshy place, notice the plants. See if you can find any of the ones there that you see in these pictures.

THINK AND TALK ABOUT THESE THINGS

1. Plants need warmth, light, moisture, and soil for growing. Talk about the plants you see growing near your school. How are they fitted for growing there? What plants that you know about couldn't grow near your school?

2. Plants that live in the desert could not live in salt water. Discuss why this is true.

3. Plan to have someone in your class talk with the men in the weather bureau near you. They will tell you when hard frost is likely to come to your neighborhood. Why is this important information?

4. Try to find out from the weather bureau the highest temperature and the lowest temperature for your community for each year during the last ten years. Discuss how this information would help farmers and gardeners.

5. Try to find out how much rain falls on your school grounds in a year. Why is this information important?

6. In what kinds of places should you expect to find the plants growing that you see below?

Saguaro

Plantain

Iodine kelp

Arctic poppy

Fir tree

Daily Weather Record, November 29 - December 5
Monday Tuesday Wednesday Thursday Friday Saturday Sunday
Air temperature 40° 35° 53° 49°
Rain or snow None None Rain .68 inch None
Wind direction W N NE NW
Wind speed Gentle Moderate Fresh Moderate

7. Plan to keep your own weather chart for a month. Record the temperature each day. Find out how cold it gets each night by looking at the weather record in your daily newspaper. The newspapers often tell how much rain falls during each storm. Record this amount on your weather chart.

8. When you plan a garden, it is important for you to know the amount of rain that falls upon your region. You should also know another fact, too. You should know whether the rains that come to your region come rather regularly throughout the growing season. Perhaps the rains come all in one short time. How would this affect plans for your gardening?

9. Did you ever stop to think about what part of your garden or school grounds is the coldest or the warmest? You might take the temperatures of soil and air in a shady spot and in a sunny spot; in a spot where grass grows and in a place where there is only soil. You will be surprised at the differences you find. How would this record help you when you are ready to plant your garden?

The Earth

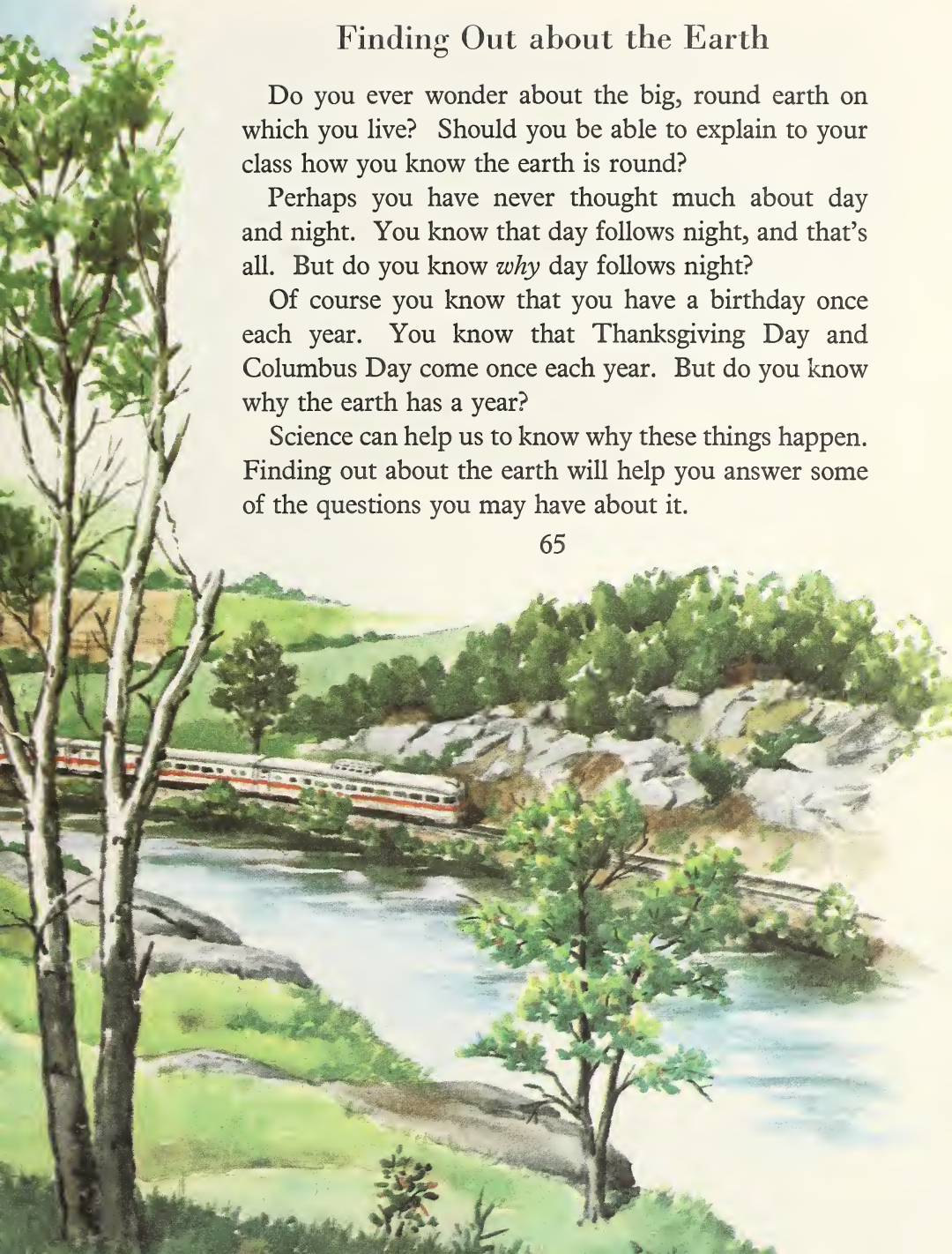
Finding Out about the Earth

Do you ever wonder about the big, round earth on which you live? Should you be able to explain to your class how you know the earth is round?

Perhaps you have never thought much about day and night. You know that day follows night, and that's all. But do you know *why* day follows night?

Of course you know that you have a birthday once each year. You know that Thanksgiving Day and Columbus Day come once each year. But do you know why the earth has a year?

Science can help us to know why these things happen. Finding out about the earth will help you answer some of the questions you may have about it.



Our Earth Is Round

As you walk to and from school, you seem to be walking on flat ground. As you look ahead, you cannot really see that you are walking on a big, round ball. But that is just what you are doing, for the earth is shaped like a big, round ball.

It is little wonder that people long ago believed the earth was flat. As you look out across the city from a high place, the earth appears flat.

As you look out over the ocean on a calm day, it too appears to be flat.

In the past some people thought the flat earth was held up by a huge turtle. Others thought that a very strong man held the earth on his shoulders.

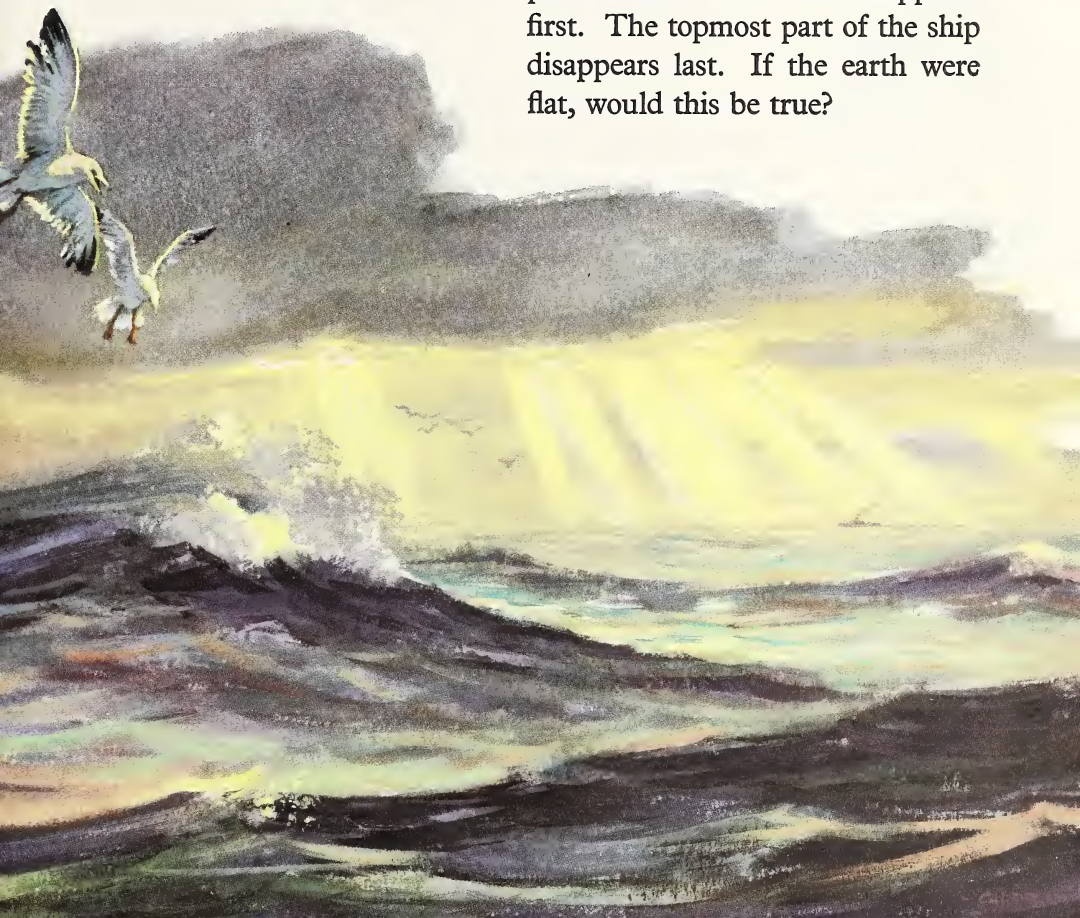
No one dared travel far out to sea for fear he would fall off the earth. People believed that monsters waited out there at the edge of the earth to swallow anyone who fell off.

These ideas seem foolish to us now. But that is because we now know several ways of proving that the earth is round. Early peoples did not have such proofs.

Long ago there were no airplanes that could fly all the way around the earth. Furthermore, no one had ever traveled all the way around the earth. There were no maps, such as we have today, to tell people about the round earth.

Perhaps you have seen pictures of some of the old maps that Columbus and other early explorers used. If you have, you know that they were not like the maps in your geography textbook. They were very crude ones indeed.

Many people who watched ships disappear must have used what they saw as a proof that the earth is round. For, as a ship sails farther and farther away, the part nearest the water disappears first. The topmost part of the ship disappears last. If the earth were flat, would this be true?



Here is another way in which some people may have come to believe that the earth is round: They watched the eclipses of the moon. Each time the earth made a shadow on the moon, it was a round shadow. The round shape of the shadow may have helped them to decide that the earth is round.

You can try this for yourself. Place a globe or a ball in the sunlight. Look at the shape of the shadow on the floor. Now place your chalk box in the sunlight. Is the shadow it makes round?

It often happens that it takes many years to convince everyone that an idea is true. At first a few people believe in an idea. They keep working to prove that their idea is true.

After a while other people become interested. They may work on the same idea in a different way. Finally, many people become convinced that the idea is true.

You will want to learn to work on ideas in this careful way. You will want to use some of the methods that the scientists use as you work to prove that an idea is true.

Our Round Earth Spins

It is not strange that men came to believe that the sun went around the earth. Long ago they did not know that the earth is spinning around and around all the time.

They saw the sun rise in the east each morning. They saw the sun set in the west each evening. It looked to them as if the sun went around the earth.

Many stories were told to explain the sun. Some people thought the sun traveled across the sky in a chariot, starting in the east in the morning.

Today we know that the sun does not travel around the earth. It only appears to move around it.

In order to understand what really happens, try this experiment: Spin a top on your table. The earth spins around much as the top spins on your table. Only the earth does not rest on a table or any other object.

Now spin a baseball fast on the table. The earth spins around and around much as the baseball spins.

The top and the ball soon stop spinning. But the earth never stops. It keeps spinning because there is nothing to stop it.

The top spins around many times in a minute. The earth spins fast, too. However, it is so large that it takes twenty-four hours to spin all the way around once.

Why Day Follows Night

Yes, our round earth spins. How does this fact help us to understand why the sun seems to travel through the sky from east to west?

Suppose you try this experiment: Pull down the shades. Place a lighted flashlight at one end of a table. Now place a globe at the other end of the table. If you haven't a globe, a big ball will do.

Look carefully to see how much of the globe is lighted. Can you place the flashlight so that half of the globe receives light?

Now have someone turn the globe. Be sure to turn it toward the east because that is the way our earth turns. Do different parts of the globe become lighted as you turn, or rotate, it?

Place a small paper flag on the globe at the place where you live. First, paste the flag on a stick or a pin. Then fasten it to the globe with a little bit of clay or some gum. The globe should be turned so that the flag is on the dark side of it.

Now turn your part of the earth toward the flashlight, which is being used as the sun. It is morning where you live. But you can see that the sun is not traveling around the earth. Instead, your part of the earth is turning toward the sun.

Keep turning the globe until the flag is directly in front of the flashlight. Now it is noon where you live. It is time for you to eat your lunch.

Keep on turning the globe toward the east. Soon the flag begins to move out of the lighted area of the globe. It is sunset where you live. Your part of the earth is turning away from the sun.

Keep turning the globe until the flag is directly in line with the flashlight sun, but on the dark side of the globe. It is midnight where you live.

Let's see now if we know why day follows night. First, we know the earth is round. Second, we know our round earth keeps turning toward the east.

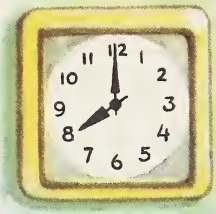
As your part of the earth turns toward the sun, you have morning and then noon. As your part of the earth turns away from the sun, you have afternoon and then evening. As your part of the earth keeps on turning toward the east, you have midnight and then morning.

Day follows night because our round earth keeps on turning. It turns all the way around once every twenty-four hours. That is why a day and a night is twenty-four hours long.

Only half of the earth gets the sun's light at one time. The other half is in darkness. Can you see that this is true of your globe?

St. Louis
6 A.M.

Paris
1 P.M.



London
8 P.M.

Fairbanks, Alaska
10 A.M.

While the city near you is having noon, another city, halfway around the earth from where you live, is having midnight. When it is morning in your city, it is evening in the city on the other side of the earth.

Suppose you live in St. Louis. It is 6 A.M. there. Look to see what time it is in Paris, France.

Suppose you live in London. It is 8 P.M. there. What time is it in Fairbanks, Alaska?

Suppose you live in San Francisco. It is noon there. Can you find a place on your globe where it is midnight?

When the children in Hawaii are having breakfast and getting ready for school, the children in Norway are having supper and getting ready to go to bed.

When the children in New Orleans are eating their noon lunch, what will the children in Italy be doing?

Norwegian children going to bed

Hawaiian children getting up

Checking
correct time
by the stars

The Earth Is a Clock

We tell the time by our clocks. When it is about eight-thirty we hurry to school. When the hands of the school clock point to twelve noon, we hurry home for lunch.

The earth is a big master clock. It tells us the correct time. We set our clocks by it.

Long ago people did not have clocks in their homes. They had only the earth and the sun as their clocks. A farmer would look up at the sun overhead and say, "It's time to eat." When the sun was low in the western sky, he would say, "It's time to rest."

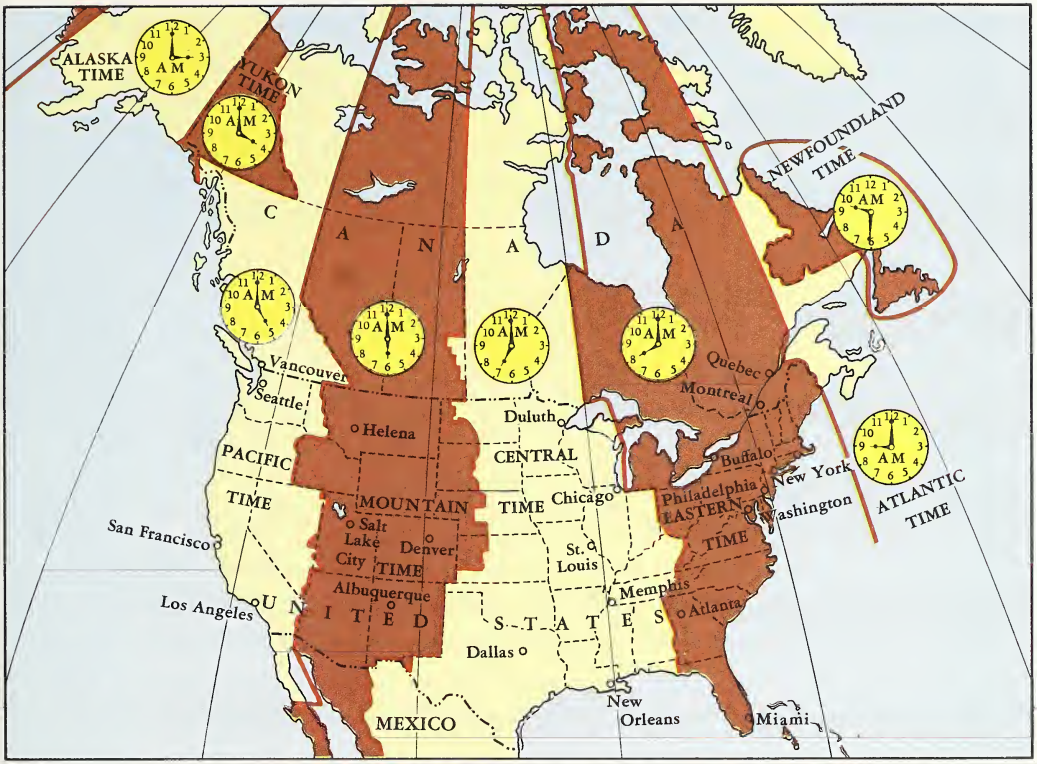
Hourglass

Many kinds of clocks were made before our alarm clock or our electric clock was invented. The Chinese used a water clock like the one in the picture below. All the water dripped from the top pail in an hour. Some other people used an hourglass. The sand flowed from one glass into the other in one hour. Others used a notched candle as a clock. It took one hour for the candle to burn from one notch to the next.

Our modern clocks tell the time better than these old clocks did. But even our newest clocks sometimes are incorrect. Many times each day we hear the correct time given on the radio. We check our clocks to see if they are correct.

The radio stations get the correct time from master clocks in Washington, D.C. These clocks are checked several times each day by scientists who know how to keep them just right. The scientists check them with the master clock which is our spinning earth.

Chinese water clock



Look carefully at the map at the top of this page. This map shows you the time zones in North America. Find the place where you live. In which time zone do you live? There is one hour's difference in time as you travel from one time zone into the next. If you travel to the east, you lose an hour. If you travel to the west, you gain an hour as you go from one time zone to the next.

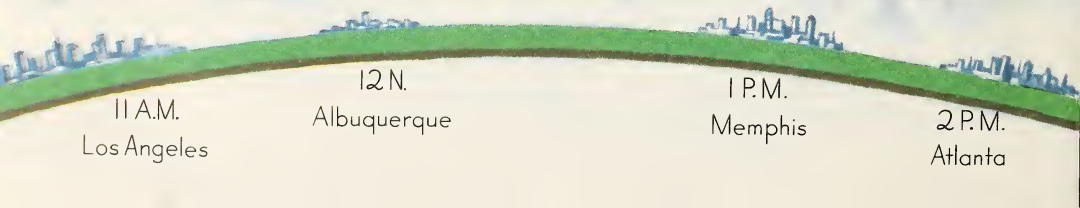
Children in Philadelphia start to school three hours before boys and girls in Vancouver, Canada, do. This is because Philadelphia is east of Vancouver and turns toward the sun first. When it is 8 A.M. in Philadelphia, it is 7 A.M. in Chicago, 6 A.M. in Denver, and only 5 A.M. in Vancouver. When it is 3 P.M. in Vancouver, it is 4 P.M. in Denver, 5 P.M. in Chicago, and 6 P.M. in Philadelphia.

When it is noon in St. Louis, it is before noon in the time zones west of it. And it is after noon in the time zones east of it.

When it is midnight in Memphis, Tennessee, what time is it in Albuquerque, New Mexico? in Seattle, Washington? in Buffalo, New York?

If you travel from Washington, D.C., to Los Angeles, in what direction are you going? You would have to set your watch three different times on the trip. Which way would you set it? Remember you are traveling west.

Now suppose you travel from Vancouver, Canada, to Atlanta, Georgia. In which direction are you traveling? You will again have to change your watch three times. Would you turn your watch ahead, or would you turn it back? If you need help, use the map on page 75.



The Earth Takes a Long Trip

Here is another experiment to try: Stand at the side of your teacher's desk. Spin around in one spot several times. Now, as you spin yourself around, start walking around the desk, too. Keep on walking and turning until you are back to the place where you started.

You have made one complete trip around the teacher's desk. In that time you spun around and around many times.

Our earth does something much like this. While it makes a long journey around the sun, it rotates many times. It keeps turning and turning as it travels around the sun.

There is another way to understand the trip that our earth takes. Draw a large oval on the floor with a piece of chalk. Let one child stand inside the oval and near the center of it. This child is the sun. Let another child be the earth. This child walks around on the chalk line. He walks to the east. He keeps spinning around as he walks. When he has gone once around the sun, a year has passed.

Another way to say this is that the earth revolves around the sun. Once in about every 365 days the earth makes one complete trip. That is why our earth year is just about 365 days long.

Inside the Earth

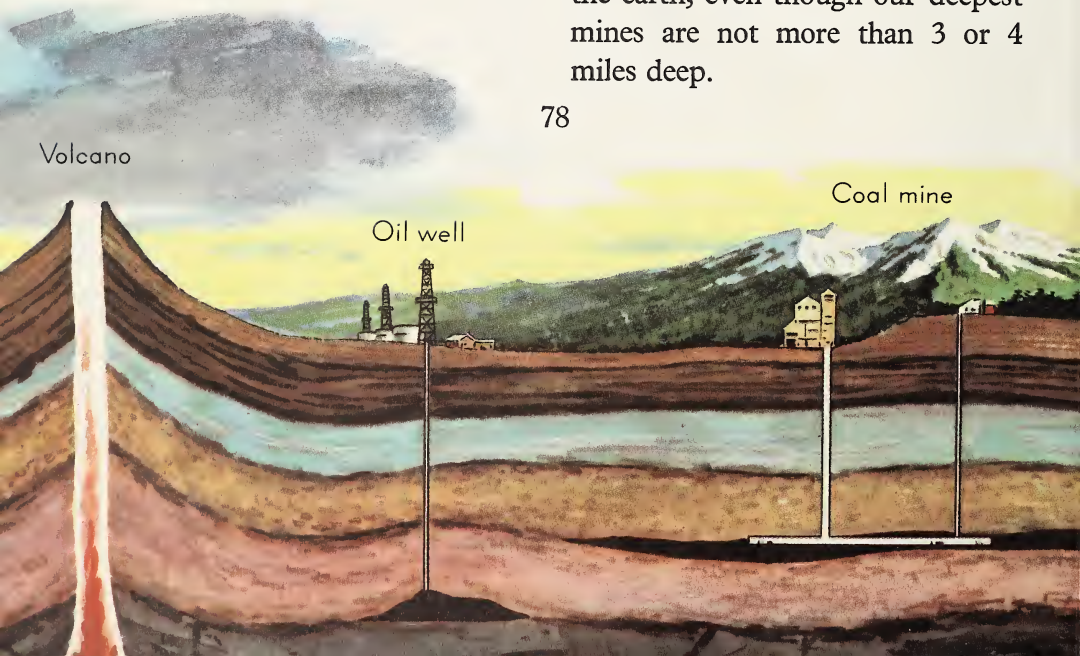
We live on the outside of the land part of our earth. Here we build our homes and work and play. We know many things about this part of the earth.

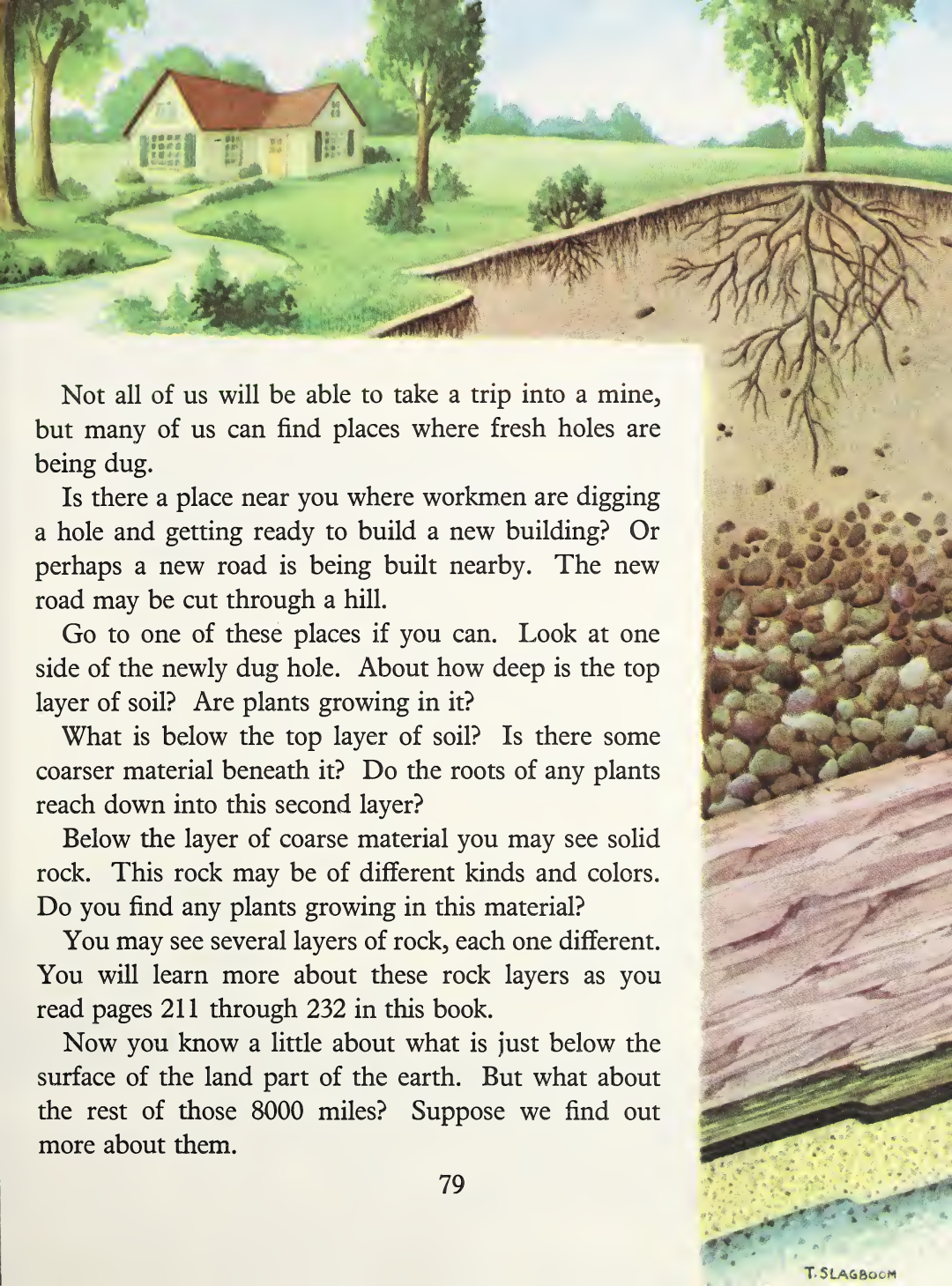
Above us and all around us is air. In fact, we live at the bottom of a great ocean of air. This ocean of air stretches above our heads for miles and miles. We know many things about the lower part of the atmosphere because we have flown into it.

What about the inside of our big earth? How much do we know about it?

No one has ever gone through the solid part of the earth from one side to the other. This is a distance of about 8000 miles. But scientists have made many explorations below the surface of the earth. They have gone down into deep mines. They have lowered cameras deep into the oceans and taken pictures there. They have flown over volcanoes and looked into the cones. They have pounded and listened to the earth's surface, much as your doctor listens to your chest when you have a cold.

Yes, scientists have found out many things about the inside of the earth, even though our deepest mines are not more than 3 or 4 miles deep.





Not all of us will be able to take a trip into a mine, but many of us can find places where fresh holes are being dug.

Is there a place near you where workmen are digging a hole and getting ready to build a new building? Or perhaps a new road is being built nearby. The new road may be cut through a hill.

Go to one of these places if you can. Look at one side of the newly dug hole. About how deep is the top layer of soil? Are plants growing in it?

What is below the top layer of soil? Is there some coarser material beneath it? Do the roots of any plants reach down into this second layer?

Below the layer of coarse material you may see solid rock. This rock may be of different kinds and colors. Do you find any plants growing in this material?

You may see several layers of rock, each one different. You will learn more about these rock layers as you read pages 211 through 232 in this book.

Now you know a little about what is just below the surface of the land part of the earth. But what about the rest of those 8000 miles? Suppose we find out more about them.

Oil, Gas, and Water Are inside Our Earth

In many places over our continent thousands of barrels of oil are pumped out of the earth each day. If you drive along some parts of the western coast of North America, you can even see oil derricks out in the ocean. Here oil is being pumped from near the surface of the earth under the ocean.

In many places natural gas is piped into homes and used for heating and cooking. This natural gas comes from inside the earth. Some comes from near the earth's surface. Some comes from deep inside the earth.

There are many things we do not yet know about the inside of the earth. People who have studied our earth know there are places near the surface that are very hot. Yellowstone Park has some of these places in it. In this national park hot water shoots out of geysers and bubbles out of hot springs.

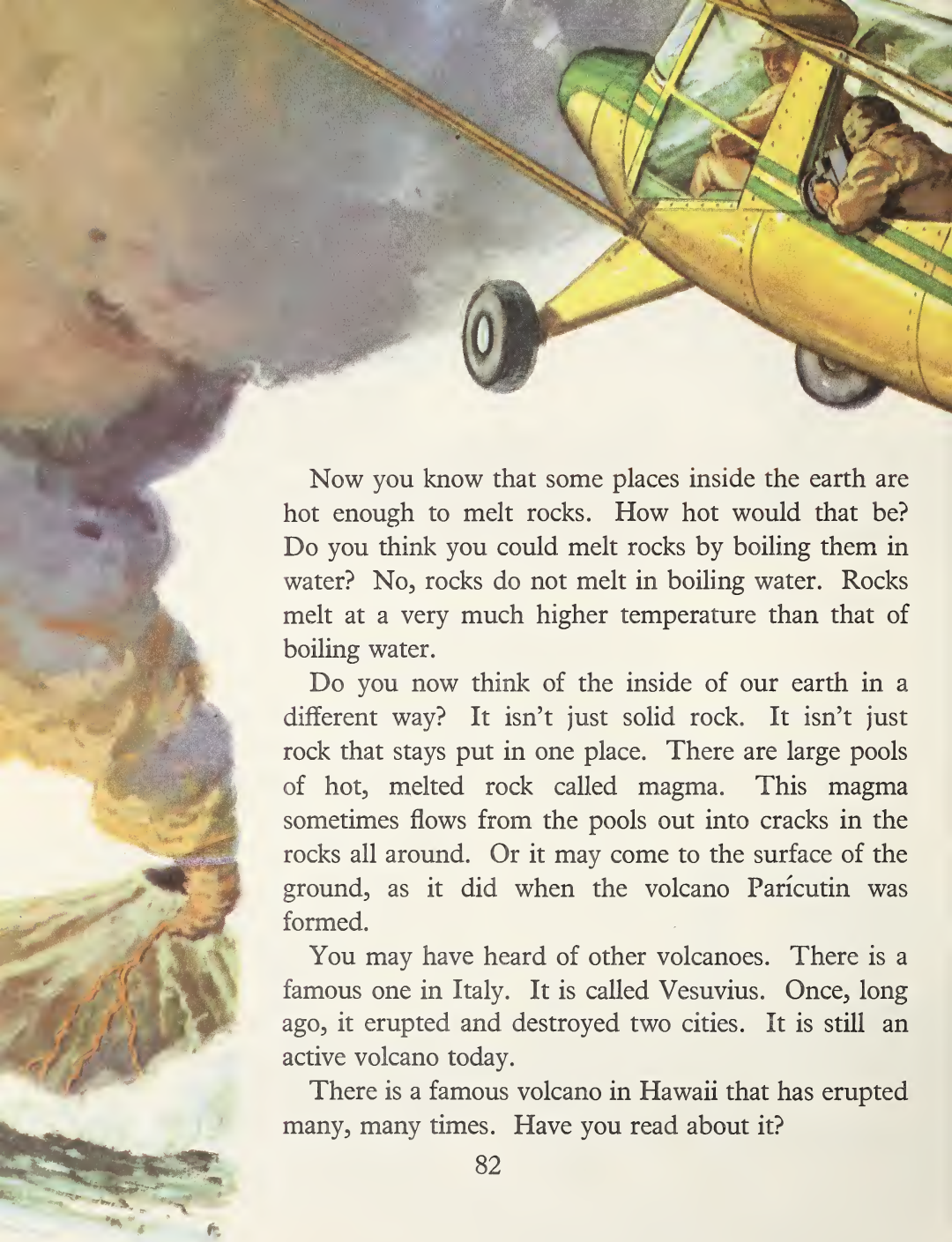
Of course we do not know whether the inside of our earth keeps on getting hotter and hotter right to the center of it. But it is believed that the inside of the earth is very, very hot.

When Volcanoes Erupt

Every once in a while you hear of a volcano erupting. Volcanoes are mountains that sometimes send forth hot gases and rock materials. The rock may be so hot that it has melted. It cools and becomes solid again as it flows down the sides of the mountain.

Volcanoes do not keep on shooting hot gases and rock into the air all the time. In fact, there are very few volcanoes that erupt often. Most of them stay quiet.

Not long ago a new volcano rose up out of a cornfield in Mexico. The ground felt warm around the farmer's feet. He heard rumbles which sounded much like thunder. Suddenly the earth ahead of him broke apart and began to rise. Hot, melted rock called lava shot away up into the air. Within a week's time the mountain called Parícutin had started to form. The farmer could no longer grow corn on this part of his farm.



Now you know that some places inside the earth are hot enough to melt rocks. How hot would that be? Do you think you could melt rocks by boiling them in water? No, rocks do not melt in boiling water. Rocks melt at a very much higher temperature than that of boiling water.

Do you now think of the inside of our earth in a different way? It isn't just solid rock. It isn't just rock that stays put in one place. There are large pools of hot, melted rock called magma. This magma sometimes flows from the pools out into cracks in the rocks all around. Or it may come to the surface of the ground, as it did when the volcano Parícutin was formed.

You may have heard of other volcanoes. There is a famous one in Italy. It is called Vesuvius. Once, long ago, it erupted and destroyed two cities. It is still an active volcano today.

There is a famous volcano in Hawaii that has erupted many, many times. Have you read about it?

When Earthquakes Happen

You have seen that magma from the inside of the earth will force its way up against the crust of the earth. When it does this, it may either pour out as lava or lift up hills or pile up rocks.

There are other kinds of changes caused by flowing magma. Sometimes, as magma flows, it causes the earth's surface to shift. When a part of the surface shifts into a new position, an earthquake happens. Flowing magma is one cause of earthquakes.

Earthquakes help us to understand a little more about the inside of the earth. There are earthquakes somewhere almost every day. This means that rocks inside the earth keep moving much of the time. In some places the rocks may wrinkle, or fold, or they may buckle or break.

We know about these earthquakes because of a machine which records them. This machine is called a seismograph.

Most earthquakes do very little damage. But every once in a while an earthquake causes great damage. Buildings may be shaken down. Sometimes fires start, and buildings are burned. Sometimes, too, people are hurt.

People who have studied the earth know where earthquakes are likely to occur. Buildings in these regions are now built in a special way. They are built so that earthquakes cannot damage them easily.

Earthquakes most often occur in the mountains under the sea, and sometimes volcanoes erupt there, too. When one or both of these things happen, giant waves of water may be started. As these giant tidal waves reach land, they may do much damage.

Tidal wave

More for You to Talk about and Do

1. It is interesting to think about how people come to believe what they do. Long ago people believed the sun traveled around the earth. What did they see happening every day that made them believe they were correct?

2. Scientists keep studying our earth. They keep finding out new truths about it. The new truths often prove that earlier ideas were not correct. Try to find out what people who lived long ago believed about the earth. Try to find out what the Indians, the Greeks, and the Egyptians believed. Can you tell your classmates about an idea that you once thought was true, but that you now know to be false?

3. The next time you take a ride on a merry-go-round, think of this: You ride around and around the music box in the center. Suppose you think of the music box as the sun. You are making a trip around it as you ride on your horse. This trip is similar to the trip the earth makes around the sun once in about every 365 days.

4. Jane lives in Quebec, Canada. She likes to listen to the football game in Pasadena, California, on New Year's Day. The game begins at 2 P.M. Pacific time. When should Jane turn on her radio in Quebec? The map on page 75 will help you.

5. How many trips has the earth made around the sun since you were born? When you are fourteen years old, how many trips will the earth have made during your life?

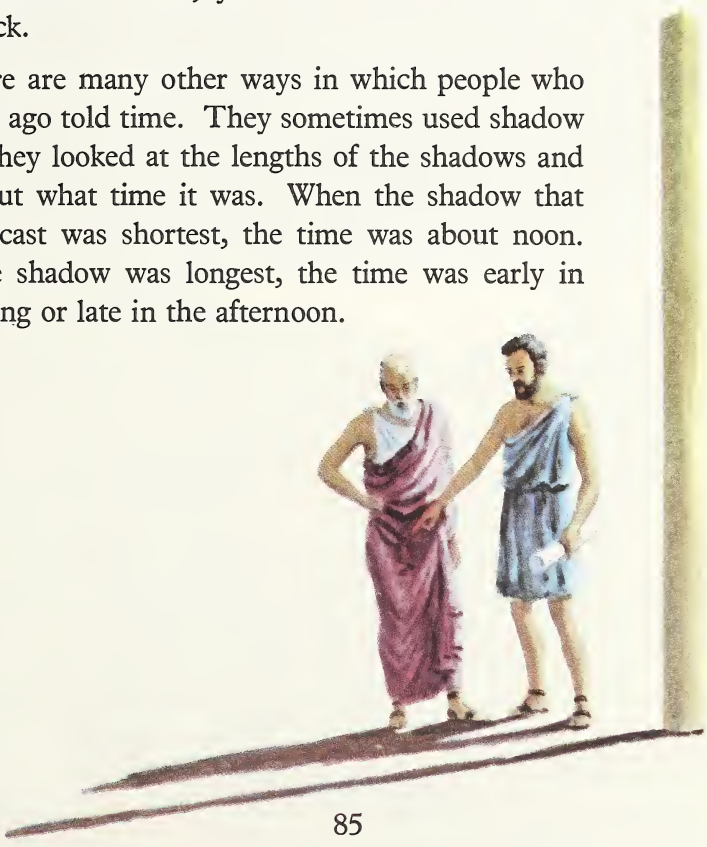
6. Use a globe and a flashlight and see if you can explain to your class exactly what causes day and night.

7. See if you can locate a sundial near your school. Ask to go there and have the fun of learning how a sundial is used for telling time.

Sundial

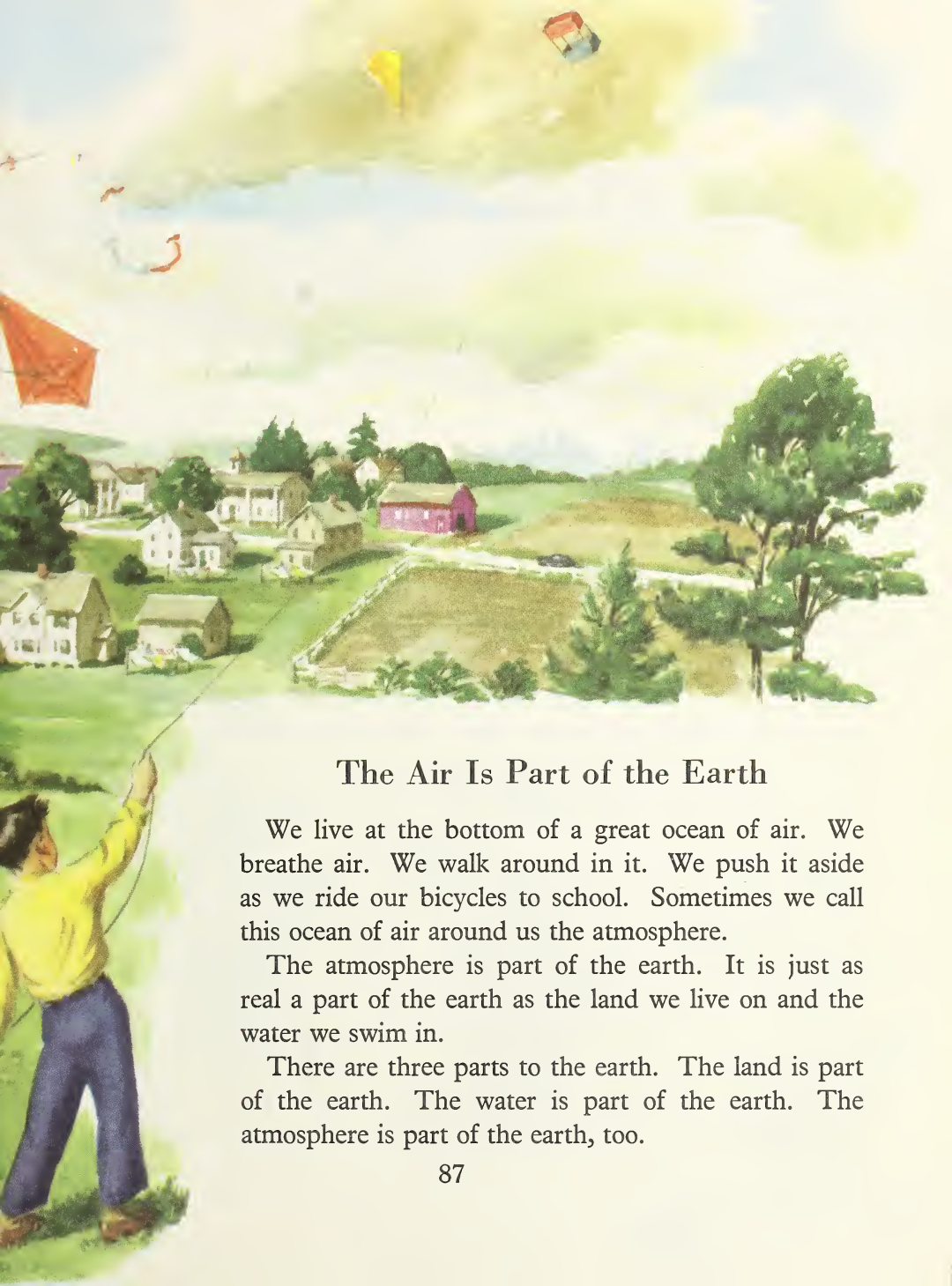
8. Try to make a simple water clock. Use a tin can. Punch a little hole in the side of it near the bottom. Fill the can with water. Let the water drip out slowly into a dish. Time the dripping to see just how long it takes for all the water to drip into the dish. Did it take a half-hour? If so, you have made a half-hour water clock.

9. There are many other ways in which people who lived long ago told time. They sometimes used shadow sticks. They looked at the lengths of the shadows and knew about what time it was. When the shadow that the stick cast was shortest, the time was about noon. When the shadow was longest, the time was early in the morning or late in the afternoon.



Shadow stick

The Air We Live In

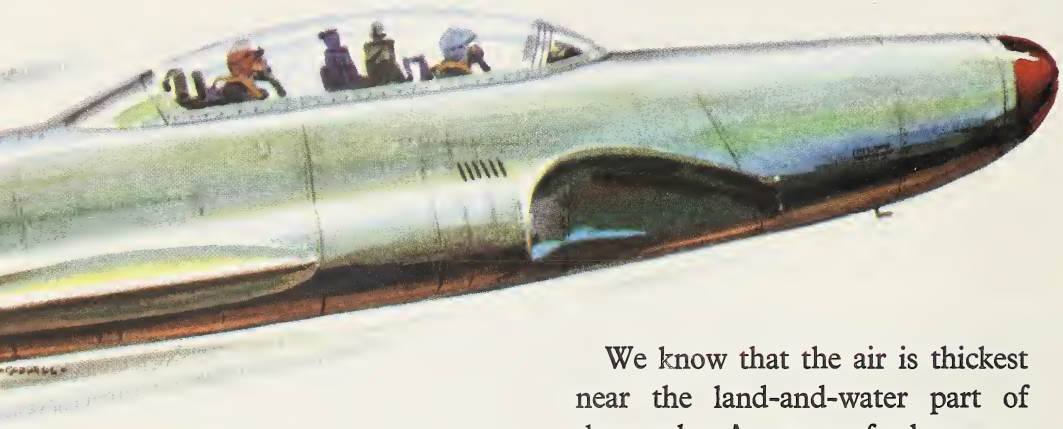


The Air Is Part of the Earth

We live at the bottom of a great ocean of air. We breathe air. We walk around in it. We push it aside as we ride our bicycles to school. Sometimes we call this ocean of air around us the atmosphere.

The atmosphere is part of the earth. It is just as real a part of the earth as the land we live on and the water we swim in.

There are three parts to the earth. The land is part of the earth. The water is part of the earth. The atmosphere is part of the earth, too.



We know that it is about 8000 miles through the land part of the earth. The air part of the earth goes all around the outside of this great ball of land and water. The air surrounds it much as the skin of an apple surrounds the rest of the apple.

Scientists do not agree about how far the ocean of air extends out from the land-and-water part of the earth. Some believe that air extends a few thousand miles out into space. Perhaps there is some air even as far as 10,000 miles out from the earth. Are you surprised at this?

We know that the air is thickest near the land-and-water part of the earth. As we go farther away from this part of the earth, the air gets thinner and thinner.

Have you ever had a ride in an airplane? Some airplanes can now fly several miles out into space. Some planes fly so far from the land that passengers need to wear oxygen masks when they travel in them. The air is so thin out there that extra oxygen is needed for breathing.

Airplanes that travel far out into space are now being made so that extra oxygen can be sent right into the cabins. Then passengers do not need to wear oxygen masks. The extra oxygen needed flows right into the cabins from tanks.

Air Is Everywhere

Did you ever stop to think where air is? We know it is all around us. We breathe it. We can feel it as we run fast. We can see leaves being blown about in it. Our flag waves in it.

We know there is air inside us because we breathe it in and out again. We watch animals breathe. So we know there is air in them.

Do plants use air? The answer is yes. There are many very small holes, or openings, on the underside of leaves. These small openings are places where air goes into the plant.

Suppose you spread some cold cream or other greasy material over one leaf of each of several plants. The grease will get into, or clog, the openings in these leaves.

Now watch the plants. Do the leaves with grease on them begin to lose their green color after a few days? Later do they get yellow and fall off?

If you wipe off the greased leaves before they turn yellow and drop off, they will be able again to take in air through their many small openings. They will now become green again.

We know there is air in water. We can see the air in water by heating some water in a pan. At first tiny bubbles of air gather around the sides and bottom of the pan. As the water becomes warmer, there are many, many tiny air bubbles to be seen.

Because there is air in water, some plants and animals can live there. All living things use air Those that live in water must be able to get air from it.

Is there air in soil? You can find out by pouring a glass of water upon a pot of soil or upon dry soil in your schoolyard. Do you see bubbles? These are air bubbles. The air comes out and makes room for the water to go into the soil.

There is air in cloth. The tiny holes in cloth are full of air. Hold a piece of thick cloth against your lighted flashlight. Can you see the holes? Air fills these holes.

We sometimes say air is everywhere. But is it? It is all around us. It is in the water we drink. It is in the soil, where plants grow. It is in cloth.

It seems to be everywhere. It is all around us. But does it fill all space? As we grow older, scientists may be able to answer this question for us.

Air Is a Real Thing

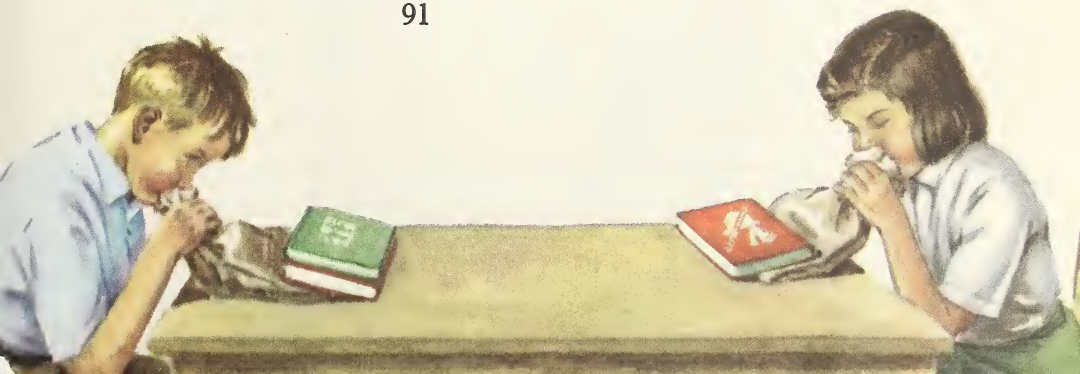
How can we prove that air is a real thing? We cannot see it; so we cannot look at it to prove that it is real. Let's try to prove it another way. Float a cork in a bowl of water. Now push a drinking glass down over the cork and into the water. Push the glass to the bottom. What happens to the cork? Why does it go down?

Try the experiment again. This time crumple up a paper towel inside the glass. Does the cork keep going down as you push the glass down?

The air in the glass pushes the cork down. Feel the paper inside the glass, and you will find that it is dry. Why does the paper stay dry? Air fills the inside of the glass. It keeps the water from coming into the glass. The paper does not get wet, because the water cannot get into the glass and wet it.

Here is another experiment for you to try: Put a paper bag on the edge of a table. Place a book on top of it. Now almost close the end of the bag between your thumb and fingers, and blow into it. What happens to the book? Did you raise the book from the table?

Now put two books on the empty bag. Can you blow enough air into the bag to raise two books from the table? Try raising more books.



How Hard Does Air Press?

Here is another fact about air: It is always pressing. Even when there is no wind, air is always pressing.

But why, then, can't we feel air pressing on us? It presses against our hands and head and legs. It presses against our eyes and arms and toes, just as it pressed against the books. Why don't we feel it?

Air presses on every part of everything. It presses on the top. It presses on all sides. It presses on the bottom. Because the pressure is equal on all sides of us, both inside and outside our bodies, we do not feel air pressing on us.

Air presses; but how hard? Let's find out. You will need your scales for weighing. Put one book on the scales. How much does it weigh? Now add more books until you have 15 pounds of books on the scales.

Lift the pile of books off the scales. They are quite heavy. They are as heavy as 15 pounds of sugar. They are as heavy as a baby who weighs 15 pounds.

The air presses as hard as that on each square inch of everything. It presses with a force of about 15 pounds on each square inch.

Now use your ruler and make a square on the blackboard. Make it 1 inch on each side. We call this square on the blackboard a square inch because it is 1 inch on each side.

Next make some 1-inch squares of paper. Cut them out. See how many inch squares of paper you can fit on the back of your hand. Did you find room for six squares?

We know the air is pressing with a force of about 15 pounds on each square of paper. The air, then, must be pressing with a force of six times 15 pounds, or 90 pounds, on that part of your hand.

Air presses as hard as that on every other part of your body too, both inside and outside. It presses with a force of about 15 pounds on each square inch of everything.

You would think we could surely feel air pressing. But as you have already read, it is pressing in all directions all the time. It pushes up. It pushes down. It pushes sideways.

Air presses on all sides with equal pressure. So we do not feel air pressing against us.

Changing the Pressure of Air

Sometimes air presses more on things than at other times. By heating and cooling air, we can change its pressure. Here is a way to prove that air pressure sometimes changes:

Boil an egg until it is hard and cool it. Then take off the shell. Place the egg at the top of an empty quart milk bottle. Does it fall in? Remove the egg.

Now crumple a little paper and put it down into the neck of the milk bottle. Ask your teacher to set it on fire and push it away down inside the bottle with a stick.

Now place the egg on the top of the bottle while the paper is still burning. Watch the egg. Does it go into the bottle?

Why did the egg go into the bottle? First, there was a fire inside the bottle. This fire warmed the air inside a little.

The warm air spread out and filled more space. We say air expands when it is warmed.

As the warm air spread out, or expanded, some of it came out of the top of the bottle. We had not put the egg into the opening yet. So there was less air in the bottle.

Less air inside the bottle meant less pressure inside the bottle. Then we put the egg at the top of the bottle. No more air could go into it. And the air inside the bottle was pressing with a force of less than 15 pounds on each square inch.

But the air outside the bottle was pressing with a force of about 15 pounds on each square inch of egg. The pressure on the outside of the bottle was greater than the pressure on the inside. The outside air pushed the egg into the bottle.

We can get the egg out of the bottle by again changing the pressure of the air inside. Blow air into the bottle as the girl is doing in the picture.

Blow hard into the bottle. Now you have put more air inside the bottle than it had before. You have now increased the air pressure inside the bottle. This air presses harder against the egg in the neck of the bottle than the air outside is pressing. Out pops the egg.

Proving that Air Expands When It Is Warmed

Here is one way to show that air expands when it is heated: Fit a balloon over the mouth of a Pyrex nursing bottle. Does the balloon hang limp?

Now hold the bottle in both hands to warm it. Or you may warm it by setting the bottle on a warm radiator or in a pan of hot water. Watch the balloon.

Does the balloon fill out? Why is this? No more air could get into the bottle. The air inside must have expanded as it was heated.

Here is still another way to show that air expands when it is heated: You will need a metal pan, a candle, and a quart milk bottle.

Heat the bottom of the candle and stand the candle in the center of the pan. Be sure that the candle sticks to the pan.

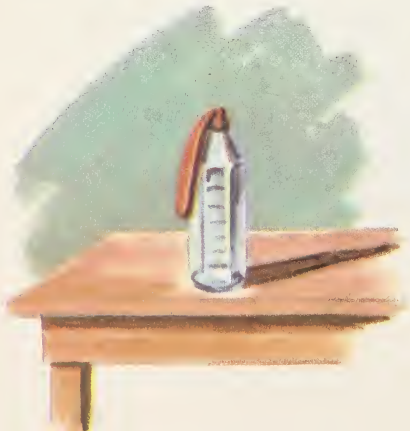
Pour about 2 inches of water into the pan. Now light the candle and place the milk bottle over it quickly.

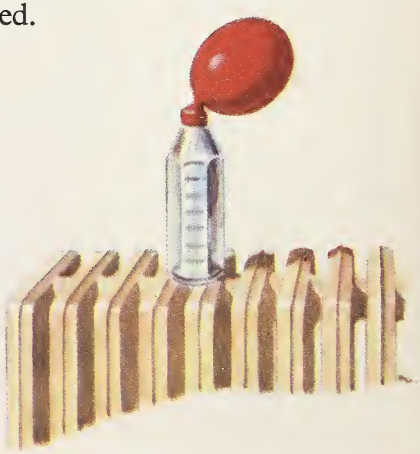
Why does the water rise in the bottle? Did you see some bubbles?

The air inside the bottle expanded as it was warmed. As it expanded, air bubbles escaped from the bottle through the water in the pan.

Also, the candle used part of the air in burning. Now there was less air inside the bottle than outside.

The pressure of the outside air pushed the water up into the bottle. The water took the place of the air that had escaped or that had been used by the candle as it burned.



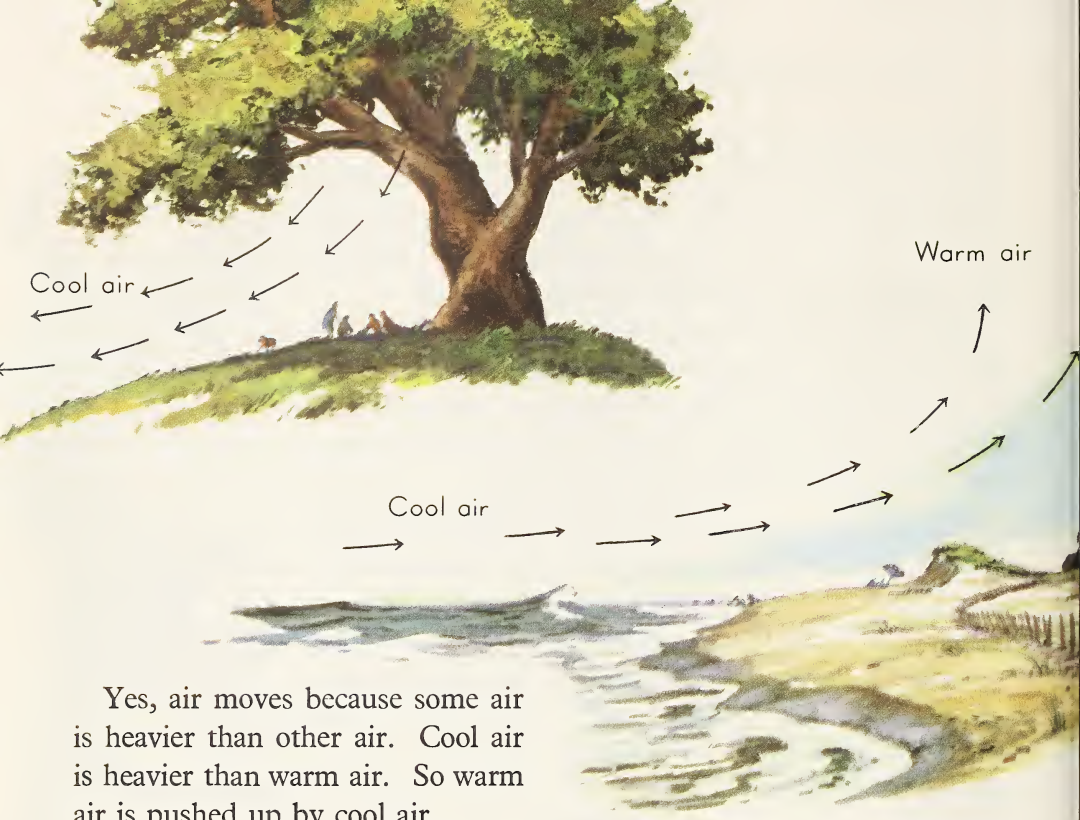


Air Moves About

We are now ready to understand why air moves about. The temperature of the air differs in different places. You may already know that this is true in your schoolroom. Air near the ceiling is usually warmer than air near the floor. You can prove this for yourself.

Put a thermometer on a low table and leave it there for ten minutes. Read it. Now hang the thermometer somewhere high in your schoolroom. Leave it there for ten minutes. Read it again. Was the air near the ceiling warmer than the air near the floor?

This is what happens inside your schoolroom: When your schoolroom is heated, the cool air near the radiator, stove, or air vent becomes warm. As the air becomes warm, it expands. And as the air expands, it also becomes lighter. Then this lighter air is pushed up toward the ceiling by cooler, heavier air.



Yes, air moves because some air is heavier than other air. Cool air is heavier than warm air. So warm air is pushed up by cool air.

Cool air over cool water takes the place of lighter, warm air at the beach. That is why in summer it is often much cooler at the beach than it is at home.

The air under the shade trees in the yard is cooler, and heavier, than the air right around it out in the sun. It takes the place of the lighter, warm air. That is one reason why you feel cool when you sit in the shade.

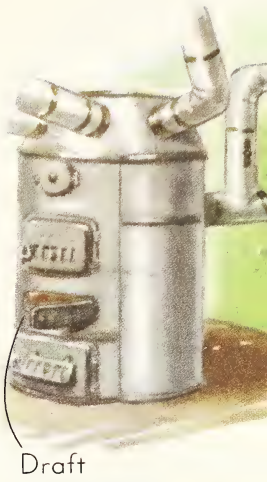
So it goes! Air over the cooler places of the earth becomes cooled. It becomes heavy too and sinks toward the ground. As it sinks, it takes the place of the lighter, warm air near the surface of the earth.

Air is always moving. It moves because of these differences in temperature and pressure. Sometimes the air moves very fast. Then we say there is a strong wind.

At other times the air moves ever so little. Then we say there is no breeze at all. Yet, even so, some air is moving. Air is always moving a little.

This moving air can do work for us. When air moves, windmills which pump water may turn. Sailboats may be blown across a lake. Our clothes dry quickly when air moves as they are hanging on the line.

If you have a coal furnace, have you ever noticed your father open the draft on the furnace when he wants to make the fire burn more brightly? This lets cool air move into the furnace, which quickly takes the place of the lighter, hot air. Really your father makes a breeze inside the furnace when he opens the draft.



If you have learned how to build a good campfire, you know that you must leave spaces between the sticks at the bottom. Then cool air can move into the fire, and this makes a breeze, or draft, of air currents in the campfire.

Sometimes air moves very fast. Then we say there is a dangerous windstorm. Windstorms do great damage. They sometimes blow buildings down. They sometimes tear roofs off barns and uproot trees. Winds like this are blowing very fast. Sometimes they blow 70 to 100 miles an hour.

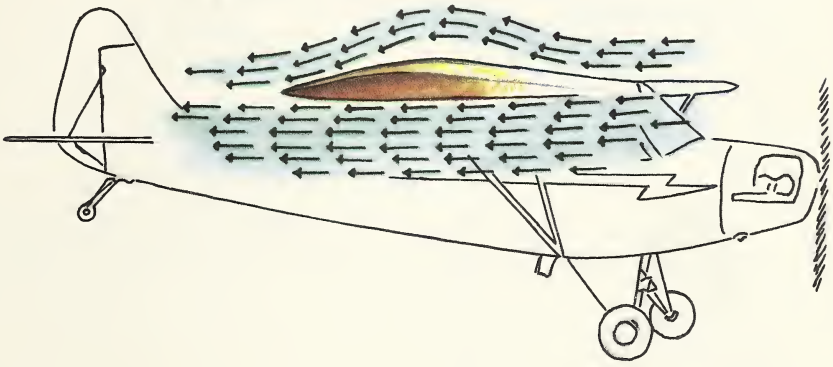
Such winds sometimes sink ships at sea. They push ships that are anchored along the shore far up on the land. They may even blow bridges down. Perhaps you have been in such a windstorm. If so, you know how much power the wind has.

Most of the time, however, the air moves gently. It moves inside our houses. It moves from outdoors into our schoolroom and makes us feel cool and comfortable.

Try to find out from your custodian how the air in your schoolroom keeps moving. He will show you how air enters and leaves your classroom. Moving air helps us to keep comfortable.

Using Air Pressure

We use air pressure in many ways. It works for us. Air pressure helps to keep airplanes up. The picture below shows you how air currents flow over and under the curved wings of a plane.



Can you see that there is a place above the wing where there is very little air? The pressure here is less than it is on the bottom of the wing. Air currents lift the wing of the plane by pushing from below.

Parachutes use air pressure, too. When a flier jumps from his plane, he falls through the air very fast. But he pulls a cord to open his parachute.

As the parachute opens, his speed of falling becomes less. This is because, as he falls, the air pressure on the undersurface of the open parachute is greater than the pressure on the top surface.

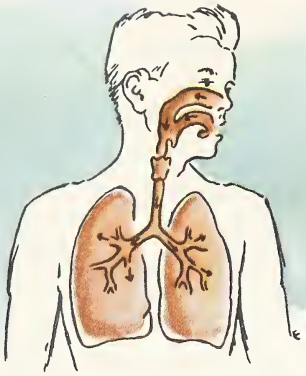
The weight of the flier makes him continue to fall, but the air pressure on the undersurface of the parachute causes him to fall slowly. With an open parachute the flier can float gently down to the ground.

Did you ever see a perfume atomizer like the one in the picture? When you press on the bulb, a stream of air and perfume comes out of the hole in the top. Can you find out how this atomizer uses air pressure?

When you drink your milk through a straw, you use air pressure. First, you pull air out of the straw by sucking on the straw.

As you keep on sucking, the milk is pushed up into the straw. The milk rises in the straw because the air pressure on the top of the glass of milk pushes the milk up into the empty straw.

There are other ways in which we use air pressure. We use it in bicycle tires and in automobile tires. We put a great deal of air in tires. This makes them hard. We say we compress the air in our tires. Can you think of other ways in which air pressure is used?



What Is Air?

As yet we have not said what air really is. Let's find out now.

Do you know what a gas is? Air is really a mixture of gases. Suppose we could see what was in a quart jar of air. Here is what would be there:

About four fifths of it would be nitrogen.

About one fifth of it would be oxygen.

There would be just a pinch each of carbon dioxide, neon, helium, and some other gases in the quart jar. There would be water vapor and dust in it, too.

As you can see, most of the air is nitrogen. We breathe this nitrogen into our bodies. But we make no use of it.

We just breathe the nitrogen right out again. We breathe out most of the other gases too—all except the oxygen.

We use the oxygen part of the air. We breathe it into our lungs. Here it goes into the blood. Then the blood carries the oxygen to all parts of the body. All parts of the body need this gas. We could not live more than a few minutes without oxygen.

As you have been reading about air, have you come to know what a very important part of the earth it is? Air makes life possible. We can ride on air. We can make air work for us. Air is as important a part of the earth as are the land and the water.

SOME THINGS TO THINK ABOUT AND DO

1. John and Tony had been on a hike. The ranger had helped them to build a campfire. They built the fire in a place that had been made safe. They cooked hot dogs. Before they started for home, they needed to put out the fire. They used sand to do this. Why will sand put out a fire?

2. Look at the pictures below and find the places where air gets to the fires. Would the fires burn without this air? Try to find out what gas in the air is used when fire burns.

3. If you blow up a balloon out of doors on a cold day and then go inside your house where it is warm, what might happen to the balloon? Try it and see.

4. Suppose you were asked to tell your friends where the atmosphere is. What would you say? Would it be correct to say, "It goes clear out to the moon"? Would it be correct to say, "It is around the earth like a blanket"? What else could you tell your friends?

5. You have learned three important things about air:

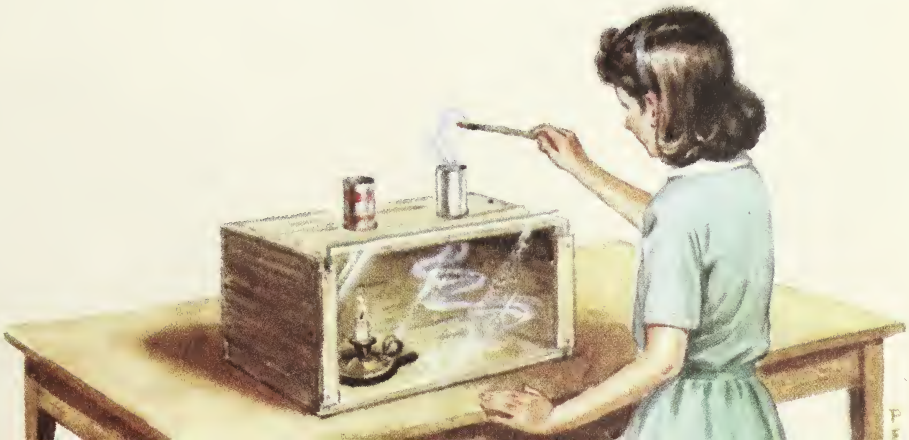
It presses against things.
It expands when it is heated.
Cold air is heavier than warm air.

These three facts help us to understand why air moves.

Here is another experiment to help you to know about the movement of air: Find a wooden box like the one in the picture below. Cut two holes in one side of the box and place it with this side up. Cut both ends off two small tin cans. Place a can over each hole. Put a short candle in the box just under one hole. Light the candle. Then cover the open side of the box with a piece of glass.

Now light a splinter of wood. Let it burn a moment and then blow it out. Hold the smoking splinter over the can that has no candle beneath it. What happens? Why?

Next hold the smoking splinter over the can with the candle beneath it. Which way does the smoke move now? After doing this experiment, what can you tell your class about how air moves?



The Sounds We Hear

Mercy, what a clatter! My, what a racket! Oh, what a screech!

Clang goes the bell! Buzz goes the doorbell! Zing goes the arrow! Quack goes the duck! And boom goes the drum!

Each sentence above describes a different kind of sound. Most of them are familiar sounds. Have you heard them many times? Do you know what makes these sounds?

What Makes Sounds?

You can find out about what makes sounds by doing these experiments:

Place your ruler flat on your desk so that some of it sticks out past the edge. Hold the ruler firmly with one hand, just as the girl is holding it in the picture. Now push down hard on the other end of the ruler. Then let go quickly. What do you hear? What do you see?

Hold the end of your pencil lightly in your fingers. Go about the room tapping it against things. You may tap the blackboard, the window sill, your book, and the metal radiator. What do you hear?

Hum a tune. While you are humming, hold your hand against your throat. What do you hear? What do you feel?

Now try this: Stretch a rubber band between your two hands. Have someone pluck the band with his finger. Watch carefully. What do you see? What do you hear?

These experiments should help you to understand what makes sounds. Did you see the rubber band moving back and forth? Did you feel something moving inside your throat? And did you feel your pencil moving in your hand? Try each experiment again and watch for the moving thing.

Sounds are made when something moves back and forth. We say that things that move in this way vibrate. The ruler vibrates. The pencil vibrates. The rubber band vibrates. Something in your throat vibrates. Yes, sound is made when something vibrates.

How Do You Hear Sound?

You may wonder how sounds reach you. Sometimes you are a long way from the place where the moving thing is. You can hear a train coming down the track while it is still far away. You can hear a cow moo away down in the barnyard. You can hear the fire siren away over on the other side of town. How does sound travel to your ears?

This experiment will help you to answer the question: Get a pan of water. Drop a small pebble into it. Do you see circles of ripples, or waves, all around the place where the pebble sank? The pebble made the water around it move.

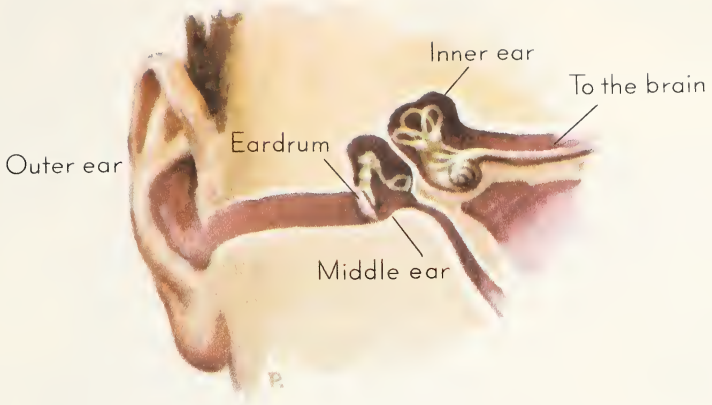
Air moves in somewhat the same way as the ripples did. You cannot see the air moving, but it moves all the same.

When you tap with a pencil, the moving pencil makes the air around it vibrate. When you pluck a rubber band, the moving rubber band makes the air around it vibrate. This vibrating air keeps making the air farther away from the pencil and the rubber band vibrate. At last the air right next to your ear is vibrating, too.

Sound travels through air to your ear. What then? By using a drum, you can understand what happens when air reaches your ear.

If you do not have a drum, you can make one. Stretch a piece of an old inner tube tightly over the open end of a nail keg or a wooden pail. Fasten it with a piece of wire as you see it done in the picture.

Now tap the drum with your hand or with a drumstick. Do you hear the sound? You made the drumhead vibrate when you hit it.



Inside your ear there is a drum. We call it an eardrum. Of course you cannot see this drum. You can see only the outer part of your ear. There are middle and inner parts which you cannot see.

The eardrum is a piece of membrane stretched tightly across the middle part of your ear. It vibrates as air strikes it. The eardrum makes other parts inside your ear vibrate.

A message from these moving, or vibrating, parts reaches your brain. Your ear and your brain work together. Together they tell you what you are hearing.

Now tap your drum again. Touch it lightly after you hit it. You can feel it vibrate. Your eardrum vibrates in the very same way. It vibrates as moving air hits it.

Yes, we hear sounds because something vibrates. The head of the drum vibrates, and we hear the sound it makes. A rubber band vibrates, and we hear the sound of it. A fire siren vibrates, and we hear the sound it makes. Sounds are vibrations which travel to our ears.

High Sounds and Low Sounds

Banjo

Violin

All the musical instruments on this page make sounds. Yet no two of them sound alike. The big bass viol makes a deep, low sound. The small violin can make a high, shrill sound. A banjo and a ukulele do not sound alike.

The big bass drum makes a lower sound than the small snare drum. Why do you suppose some sounds are high and other sounds are low?

Let's talk about the drums first. See how large the drumhead of the bass drum is. See how small the drumhead of the snare drum is.

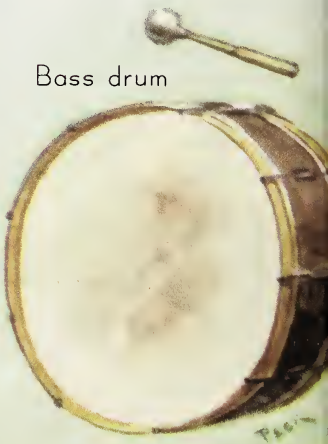
When you strike the head of the big drum, it vibrates. When you strike the head of the snare drum, it vibrates, too. But these two drumheads move, or vibrate, at different speeds.

The big drumhead vibrates more slowly than the small drumhead. The sound it makes is a low sound. The small drumhead makes a high sound.

Bass viol

Ukulele

Snare drum



Bass drum

We call this highness and lowness of sounds pitch. The small snare drum has a higher pitch than the large bass drum.

The piano may help us, too. Ask your teacher or mother to open the piano case. Look at the wire strings inside. Some of them are short. Some are long. Some are thick. Some are thin. You will notice that the longer strings are thicker than the shorter ones.

Now press down the key which goes with the shortest string. Do you hear a high sound?

Next press down the key that goes with the longest string. Do you hear a low sound?

These two strings vibrate at different rates. Each other string of the piano vibrates at a different rate. The longer, thicker strings vibrate more slowly than the shorter, thinner strings. The longer, thicker, slow-moving strings make low sounds. The shorter, thinner, fast-moving strings make high sounds.

Yes, some sounds are high, and some sounds are low. The highness and lowness of sounds you hear are called pitch.

Let's look at the violin or the bass viol. Perhaps someone who knows how to play one of these instruments will play for you. Where does he place the fingers of his left hand?

Watch him move the bow across the strings near the middle of the instrument. Does he move his fingers on the strings? Do you hear the pitch change as he moves his bow across the strings?

Perhaps you would like to listen to the sound from only one string at a time. Ask the player to play on only one string.

As the player moves his finger along that string, what do you hear?

What did the player do? As he moved his fingers up and down along the string, he made the moving part of the string longer or shorter. When he moved his finger down toward the center of the violin, he made the string shorter. As he moved his finger away from the center of the violin, he made the moving part of the string longer.

The shorter the string, the higher the pitch. The longer the string, the lower the pitch.

Making a One-String Fiddle

Some children have had fun making a one-string fiddle of their own. You may want to make one and play it.

First, get a wooden box that is not too big. A cigar box is a good size. Cut a round hole in the lid. Then tape the lid down tightly all around the edge.

Nail a wooden handle on the box just as you see it in the picture. Pound two nails in the places shown. Fasten one end of a fine wire to one of the nails. Wind a few loops of the wire around a spool. Then stretch the wire tightly and fasten it well to the second nail.

Now pluck the string just as it is. Then, as you continue plucking, move the finger of your other hand up or down along the string.

As you change the length of the moving part of the string, what happens to the pitch? Let others in your room try it. Does the same thing happen each time? If someone has a violin bow, try moving it across the string. Does the same thing happen now?

Why does the pitch change? The string vibrates faster when it is short. The pitch is higher when the string vibrates faster. The pitch is lower when the string vibrates slower.

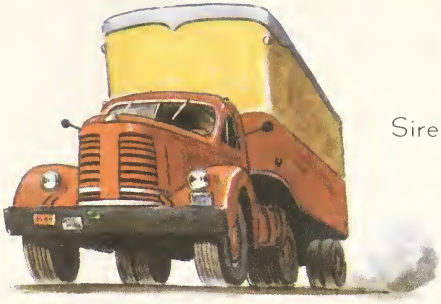
You may want to change the wire on your fiddle. Use a heavier wire. Stretch it between the nails and around the spool. Fasten it well. Now try playing it.

My what a difference! Now your fiddle sounds more like the big bass viol. It has a much lower pitch. But why?

Compare the thickness of the two wires. Which string makes the higher sound? Which one makes the lower sound? The thick wire vibrates more slowly than the thin wire. So the pitch is lower.

Another way to change the pitch of your fiddle is to stretch the wire tighter. Use the spool for this. When you pull the wire tighter around the spool, you change the rate at which the wire vibrates. Look at the picture to see how to do it. Now play on your fiddle. What has happened to the pitch?

Now you know three ways to change the pitch of your fiddle. Of course you also know that these are three ways of changing the rate of vibration. You can change the pitch by changing the length of the string. You can change the pitch by using a thicker or a thinner wire. You can change the pitch by stretching the string a little tighter.



Objects that make loud sounds

Loud Sounds, Soft Sounds

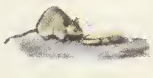
Some sounds are loud. Some sounds are soft. A cat's purr is a soft sound. A police siren makes a loud sound. A mouse's squeak is a soft sound. A foghorn makes a loud sound.

Let's see why some sounds are so loud that they hurt your ears and others are so soft you can hardly hear them.

Suppose you use your drum again. First, tap it lightly. Now tap it with more force. Which sound is louder? Yes, the last sound is louder. This is because you hit the drumhead so hard that it set more air around it vibrating.

Sounds are soft when only a little air is vibrating. Sounds are loud when a great deal of air is vibrating.

Animals that make soft sounds



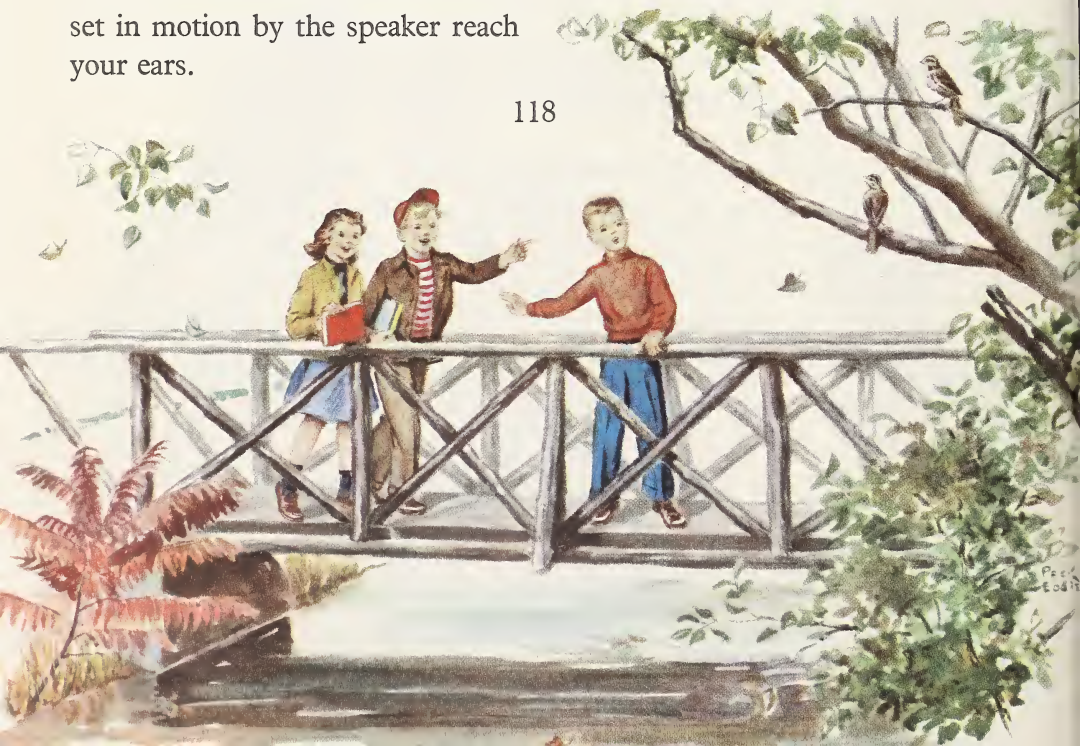
Try clapping your hands lightly. Is the sound you hear soft? Now clap your hands again. This time clap them harder. What happens? Why was this last sound loud?

Have someone go into a corner of the room and face the wall. Have him whisper someone's name ever so softly. Did anyone hear the name? If not, you know that his whisper was so soft it did not set enough air in motion to reach your ears.

Try again. Keep trying until the person whispers loudly enough for you to hear. You will hear when the air waves that have been set in motion by the speaker reach your ears.

As you walk home from school today, listen to the sounds. You may hear a song sparrow, or a mocking bird may be singing in a treetop. You may hear the gentle rustle of a leaf falling to the ground. You may hear the ripple of water as it flows along in the brook. These are all soft sounds.

The heavy rumble of a train may startle you as the express roars past. The shrill wail of a fire engine may make you cover your ears. You may hear a dog bark as you pass his house. These are loud sounds.



You may want to find out more about sounds. Go out to the playground at a time when only your class will be there. Have someone stay in the center of the playground. Now have four other children stand in the positions shown in the picture above.

The child in the center blows a whistle, beats a drum, or rattles a rattle. Ask each of the four other children whether or not he heard the sound.

If these children heard, they should move farther away from the child who is in the center. Have the children keep moving away.

Ask each child to describe the sounds he heard as he moved away. Did the sounds get softer? Did the sounds change pitch?

Here are three things to remember:

1. The harder you tap an object, the louder the sound.

2. The more lightly you tap an object, the softer the sound.

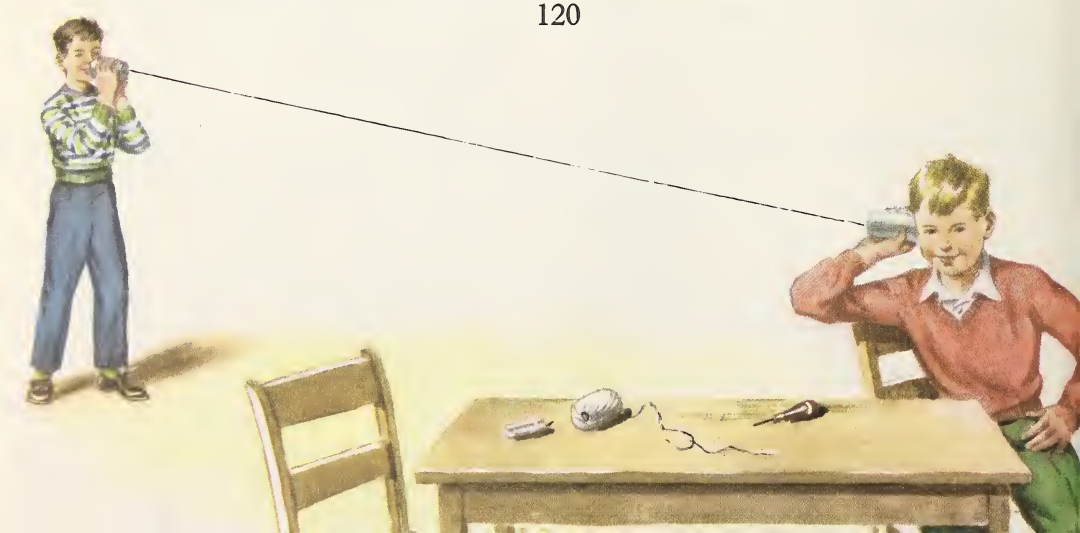
3. The closer you are to the source, the louder the sound.

Making a Telephone

The children in the picture above are making a toy telephone. They are making it from two small tin cans and a piece of strong string.

First, they punched a tiny hole in the bottom of each can. Then they waxed the long piece of string with an old piece of candle. They will put the string through the holes in the cans and tie a knot at each end so that the string cannot pull out through the holes.

Now they are playing telephone. In the picture below Bob is talking into the can. He has it close to his mouth. Bill is listening. He is holding his can close to his ear. The string is stretched tightly.

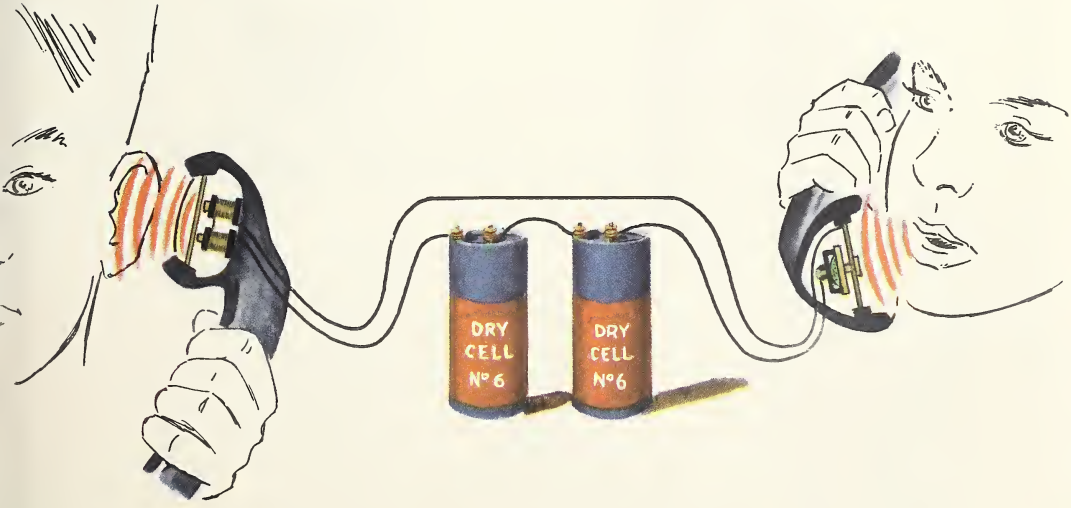


Bill and Bob seem to be having fun. Bill looks as though Bob were telling him something interesting. No one else can hear their secret.

The air inside Bob's can is vibrating. These vibrations are going along the tightly stretched cord. The cord makes the air in Bill's can vibrate. This air carries Bob's message to Bill's eardrum. That is why he can hear what Bob is saying.

Your telephone in your own home works in much the same way. You talk into your telephone to your friend. Your voice does not travel over the wire to your friend's house. The sound waves of your voice cause a metal disk inside the mouthpiece to vibrate.

A current of electricity travels over the wires. The vibrations of the metal disk in the mouthpiece cause the electric current to become strong some of the time and weak some of the time. This electric current causes a metal disk inside the receiver to vibrate in the same way. Your friend hears what you say as you speak into the mouthpiece of your telephone.



Vibrations Travel through Many Things

We know now that sound is vibration. We sometimes say that sound travels to our ears. What we really mean is that vibrations travel to our ears.

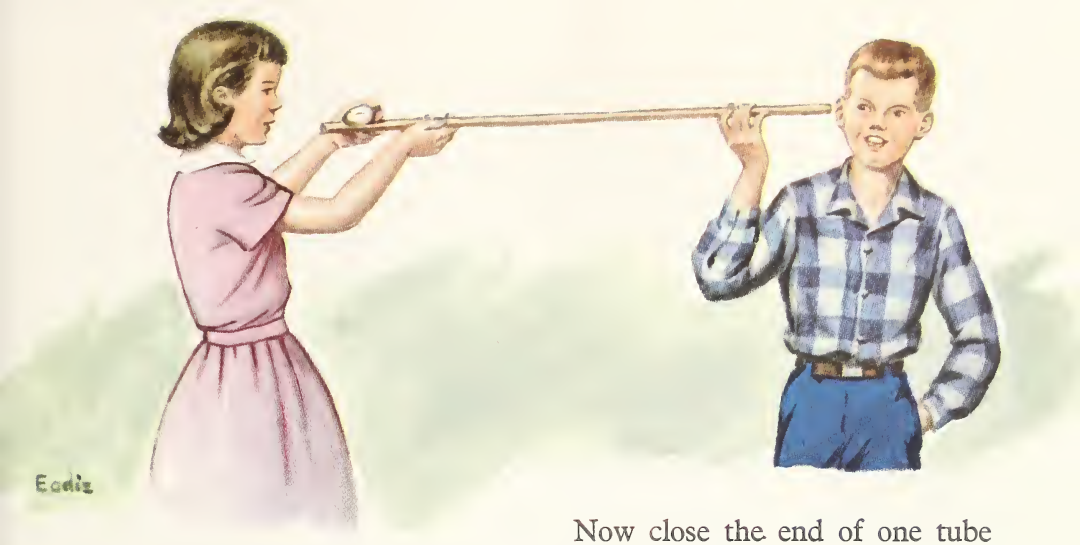
We know we can hear the sound of a branch breaking because the air around it vibrates. When these vibrations reach our ears, we hear the sound of the branch breaking.

Do vibrations travel through metal? One afternoon, at Bob's home, Bob and Bill tried an experiment that answered this.

Bob went down into the cellar and stood near the water pipes. Bill went into the bathroom upstairs, where the same water pipes were.

Bob tapped lightly on the pipes in the cellar with a metal hammer. He asked Bill to answer back if he heard any sound.

Bill tapped three taps on the pipes in the upstairs bathroom. That was his answer to Bob. Both boys now knew that vibrations do travel through metal.



Do vibrations travel through wood? Try this and see: Hold a yardstick near your ear. Have someone hold a watch at the other end of the stick. Can you hear it tick? Can you hear it better when you hold the watch the same distance away, but not near the stick?

Try putting the watch at many places on the yardstick. Try putting it on other wooden objects.

Can you hear through wood? Can you hear better through wood than through air?

Do vibrations travel through soil? Try this and see: Get two empty cardboard tubes. Hold a watch at the bottom of one tube and listen.

Now close the end of one tube and pack it full of soil. Hold the watch at the bottom of first one tube and then the other. Can you hear the ticking more clearly through the tube with the soil in it? Do vibrations travel better through soil than through air?

Can vibrations travel through water? If you have ever swum under water or dived into it, you may know the answer. Yes, vibrations travel well through water.

A sound under water is much louder than the same sound would be in the air. Vibrations travel better through water than through air. They also travel better through wood, metal, and soil. Air is really not a very good conductor of sound vibrations.

What Is an Echo?

Tony and Pete were fishing. They were away down in the valley between two high, steep hills. Tony said, "Hey, Pete, I bet you can't do this." He put his hands up to his mouth and shouted, "Hello, hello, hello."

They listened. Soon they heard a soft answer: "Hello, hello, hello." Then Pete tried it. They listened and heard the soft answer again.

They were hearing an echo. The sound of their own voices came back to their ears.

Tony and Pete had set air moving when they shouted. The moving air waves had hit against the side of a hill. The air waves could not go forward. So they had bounced back to the boys' ears.

Sometimes you hear an echo when you are between tall buildings. The moving air bounces back to your ears. It strikes the tall walls and bounces back. You hear your own voice again.

The same thing can happen in a tunnel or under a bridge or in a court between two apartment houses. Try it and see.

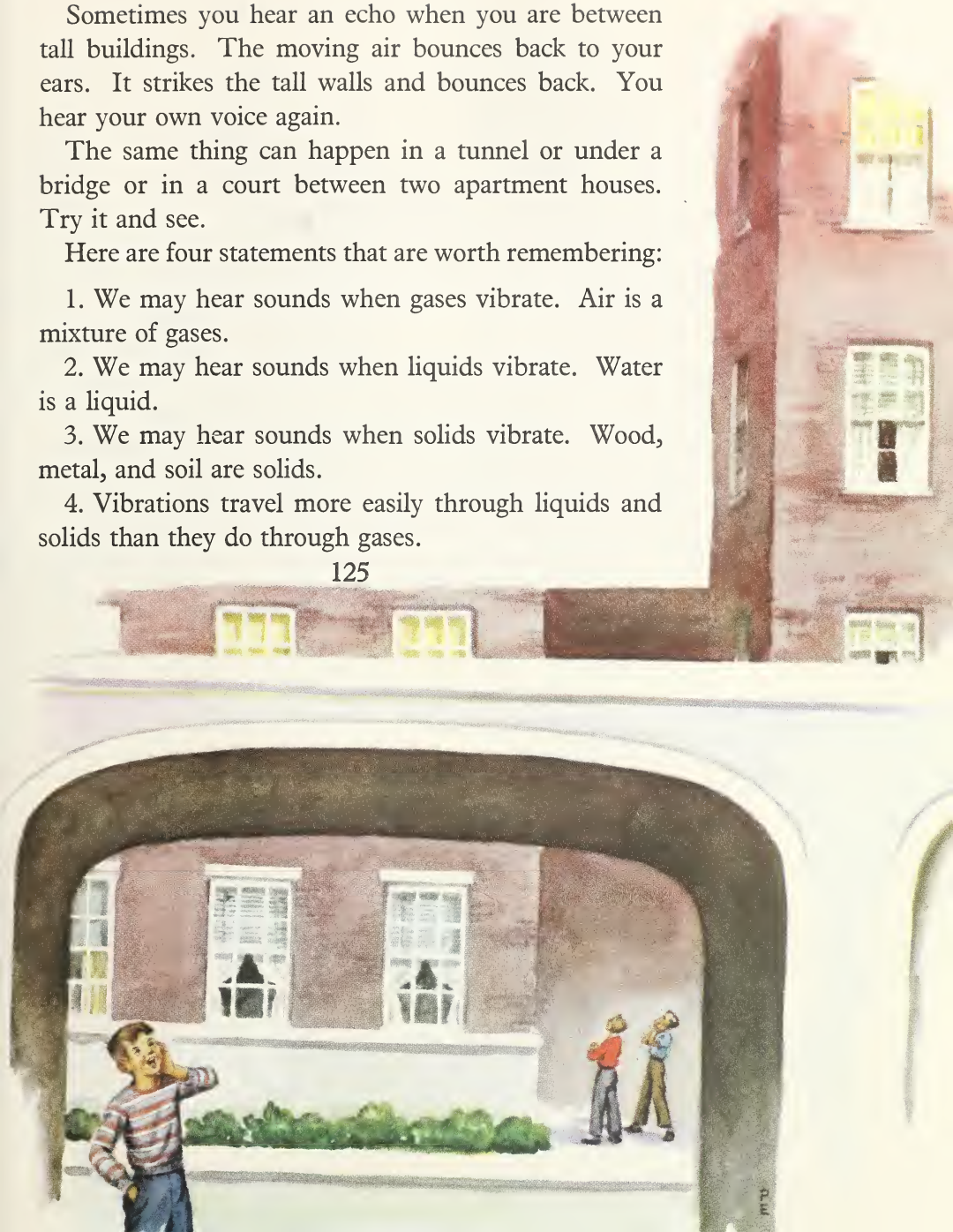
Here are four statements that are worth remembering:

1. We may hear sounds when gases vibrate. Air is a mixture of gases.

2. We may hear sounds when liquids vibrate. Water is a liquid.

3. We may hear sounds when solids vibrate. Wood, metal, and soil are solids.

4. Vibrations travel more easily through liquids and solids than they do through gases.



1. Try this with a kitchen fork. Strike the prongs of the fork against the felt of a blackboard eraser or your rubber heel. Do not hit it against your desk. Then quickly put it near your ear. Do you hear the sound of the vibrating fork? Do it again. You can use a tuning fork instead of a kitchen fork, if you have one. The vibrating prongs of the tuning fork will make a louder sound.

2. Here is another experiment you may do with a fork: Stick a threaded needle into a cork. Knot the thread and hold it so that the cork and needle are free to swing. Strike the fork against your rubber heel. Now hold the fork as it is being held in the picture. What happens to the cork? Why does it move?

3. Many animals make sounds. Some sing, some croak, some hammer against trees, and some make sounds by rubbing their legs and wings together.

Below are pictures of some animals that make sounds. Can you find out how these animals make the sounds they do?

4. These musical instruments all make sounds. The next time you have a chance to listen to an orchestra, try to find out what parts vibrate to make the sounds. See if you can discover how changes are made in the sounds of each instrument.

5. It is fun to play the game of Echo. Find different places in your neighborhood where echoes are heard easily. A good place is in a tunnel or between two tall buildings or between two tall hills. Try to find out why echoes are easily made in these places.

How Plants Grow

Plants That Grow from Seeds

Did you ever stop to wonder why there are so many plants on this earth? Almost any place you go, you will find some kinds of plants. Yet if there were no way for new plants to start growing, the earth would soon have no plants on it.

Many plants that you see every day grow from seeds. Corn and wheat grow from seeds. So do beans and peas. The big oak tree in the forest grew from a small acorn. An acorn is really a seed. The red and white clover in the fields grew from very tiny clover seeds.

If you were asked how plants start to grow, you might answer, "They grow from seeds." But not all new plants start that way. It will be fun to find out about several other ways. Because you may have thought of seeds first, let's begin with them.

Where Seeds Are Found

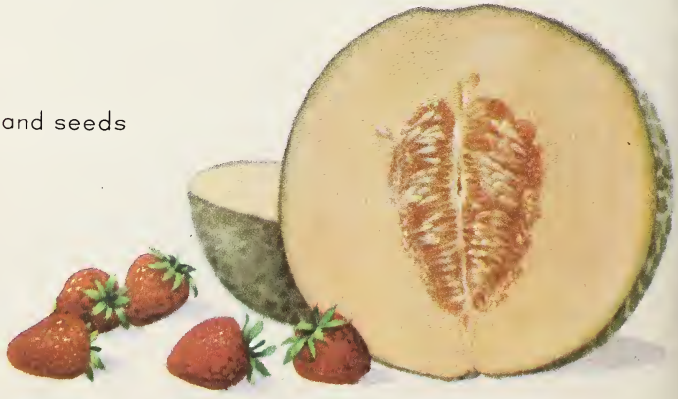
When you bite into the fruit of the peach tree, you find one large seed in the middle of it. When you bite into the fruit of the apple tree, you find several small seeds. When you cut open the fruit of the watermelon plant, you find many, many seeds.

Most seeds grow inside the fruit of plants. Often we think of fruit as growing only on such plants as orange and apple trees. But the pod full of peas is the fruit of the pea plant. The cucumber that you eat is the fruit of the cucumber plant. The ear of corn is the fruit of the corn plant, and the tomato is the fruit of the tomato plant.

The berries you eat are fruits, too. The red strawberry is a fruit, with its seeds scattered over its surface. The blueberry is the fruit of the blueberry plant. Can you name other kinds of berries?

Some berries are really many tiny fruits clustered together. The next time you see red raspberries or other berries, look at them and see whether they are single fruits or clusters of fruits.

Fruit and seeds



Where Seeds Form on Flowering Plants

Wherever you live, there will be some plants near you that grow from seeds. Many of the plants that grow from seeds are flowering plants.

Some flowering plants are easy to name. Many that grow in your garden have beautiful, bright flowers. It is easy to know that these plants are flowering plants because their flowers have such bright petals.

Most vegetables and grains are flowering plants, too. Many trees have flowers, but you may never have noticed these flowers. The flowers of some trees and those of some other plants have no petals. They are not so bright and beautiful as flowers with petals. They are hard to see.

As the petals of flowers dry up and fall, you will be able to see the seeds forming. They form at the bottom of the flowers. They have been forming while the plant was blossoming.

You may have a chance to watch beans or peas grow. Can you see that the pods are growing larger? Sometimes the seeds are so large that you can count them in a pod before it is opened.

Willow

Oats

Maple

Cosmos

Clover

Dahlia

Inside a Seed

It is fun to watch seeds grow. No matter where you go to school, you can experiment with growing plants from seeds. If your school is in a city, you may want to grow some plants indoors and some plants outdoors.

You can grow some of your seeds in water and some in soil. Here are some things you may wish to do so that you may find out more about how plants grow from seeds.

Get a package of Lima-bean seeds at a seed store. Soak them overnight, so that the hard, outside coat becomes soft.

Take this outside coat off a few seeds and split the seeds down the middle. Now look carefully and see if you can find a tiny new plant on one of the parts of each seed you have opened.

This is the only part of the seed that can grow into a new plant. The rest of the seed is food, which the young plant uses as it starts growing. You may wish to look for tiny plants inside some other kinds of seeds, too. Soak and split corn, pea, or pumpkin seeds. Look for the new plant that has formed inside each seed.

How the Young Plant inside the Seed Grows

Now that you know that there is a young plant inside each of your Lima-bean seeds, you will want to watch these young plants grow. You may be able to watch them grow by doing this:

Soak several seeds overnight and then lay them on a flat piece of cotton. Place the cotton between two pieces of glass. Then tie string around the pieces of glass to hold them in place. Carefully set the pieces of glass on end in a dish of water as shown in the picture. The cotton will become moist from the water in the dish.

Now set the dish in a sunny warm place in your schoolroom. Watch to see what happens. You will want to keep a record of what happens. Your record might be kept somewhat like this:

Our seeds were planted on March 1
We saw the young plants March 4
The roots grew 1½ inches the first week
The stems grew ¾ inches the first week

Growing New Plants

Cotton plants

Here are some ways in which some of you might like to experiment:

1. Get a sponge. Place it in a shallow dish of water. Sprinkle grass seed over the top of the sponge. Be sure to keep the sponge damp. Soon you will see tiny plants growing. Each tiny plant grew from inside one seed. Keep a record of your experiment.

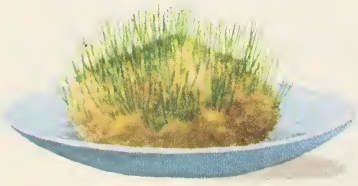
2. Get several 2-inch flowerpots. Fill them with good soil. Plant two seeds of corn in one, two grapefruit seeds in another, two cotton seeds in another, and two lemon seeds in a fourth. If you cannot get these seeds, use whatever seeds you have at hand. Keep the soil damp. Set the pots in warm, sunny places and watch the plants grow. Each plant grew from a tiny plant inside the seed.

Grapefruit plants

3. You may wish to see just what is happening to seeds each day as they grow. Fill a wooden box or milk carton with good soil. Plant several of the same kind of seed in the soil. Each day carefully dig one seed out of the soil. Look at it. Keep a record of what is happening each day.

4. The next time your mother serves an alligator-pear salad, ask her for the pit. This pit is the seed of the alligator pear. Take off the brown, outside coat.

Grass



Lima-bean seeds sprouting

Alligator pear

February 15

February 27

March 9

Place the seed in a glass jar partly filled with water. Keep the jar in a dark place while the roots are growing. It will take the roots several weeks to grow.

Bring the jar out of the dark place when the roots are well started. Now you will have to wait again. One day, however, the big seed will begin to split open. Then you will be able to see the stems and leaves of the new plant growing inside. Keep a record of this experiment too.

5. Sometimes you may wish to plant seeds in water. Later you may wish to put the young plants in soil. You can use flowerpots or tin cans filled with soil. Punch holes in the bottoms of the tin cans, so that when you water your plants, the extra water can drain out. Your plants will grow for a long time, now that they are planted in good soil.

From these experiments you will find out that a young plant starts growing when water and warmth and food are near it. Food stored around it in the seed is used first. Then the plant's roots grow down into the soil. Its stems and leaves grow up into the light.

The plant gets water from the soil through its roots. Food for the plant is made in its green leaves.

The tiny plants inside some seeds grow quickly. Rye, grass, bean, and radish plants grow quickly. The tiny plants inside some other seeds grow slowly. Grapefruit and lemon plants inside seeds grow ever so slowly.

Seeds are really wonderful things. The plants inside some of them can live in the seeds several years and can stand heat and cold. If the seeds are put in water or soil and kept warm, the plants inside begin to grow.

Sweet potato

Carrots

Growing Plants from Roots

This may seem odd to you: many of the plants that form seeds can start new plants in other ways too. Sometimes stronger plants can grow from the roots or stems or leaves of a plant than from the seeds of that plant.

You may wish to try growing new plants from roots. One root that you can grow is a sweet potato. Did you know that a sweet potato is really a root?

Look at the picture and place your sweet potato in a glass as shown there. Only part of the sweet potato should be in water. But be sure the pointed end of the sweet potato is kept covered with water. New, smaller roots will grow from this end. If you set the jar in a dark place for a few days, the roots will get a better start. Add water as you need to.

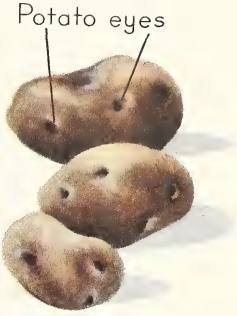
The sweet potato will first put out small roots, which grow in the water. Then it will send out stems and green leaves above the surface of the water.

You might like to grow a new dahlia plant from the root of an old plant. Plant the dahlia root out of doors if you have space to do so. Then it will grow and flower there. Or plant the root in a large flowerpot if you wish to grow it indoors.

It is fun to grow new tops from beets or carrots. Both these vegetables are roots. Cut 2-inch pieces off the top ends of the roots. Stand the pieces in a shallow bowl with pebbles and water in it. The pebbles help to hold the pieces in place. In a little while you will see leaves growing out of the tops of the roots.

Growing Plants from Stems and Leaves

New plants grow from the stems of some plants. You may wish to experiment with these plants too. There are several kinds of stems that you may use. The white potato you eat is called a tuber. A tuber is really an underground stem. The onion you eat is called a bulb. It is really a stem, too.



It is easy to watch new plants grow from an old potato. Choose a potato with white sprouts growing on it. The sprouts grow out of the places called eyes. The eyes of the potato are buds. They are the only places where the new plants can start growing.

Now cut the potato into pieces. Be sure you cut it so that there is an eye or a sprout in each piece. Plant the pieces of potato in small flowerpots indoors or in a garden spot outdoors. A new plant will grow from each eye or sprout.

You may also wish to grow a new plant from an onion bulb. Place the bulb in a shallow glass dish. Put pebbles around the bulb to keep it standing up. Now put just enough water in the dish to cover part of the bulb. Keep the water at this level. Put the dish in a warm, dark place for a couple of weeks, so that roots can begin to grow. Then bring the dish with the onion bulb out into the bright sunlight. Now green leaves will start to grow.

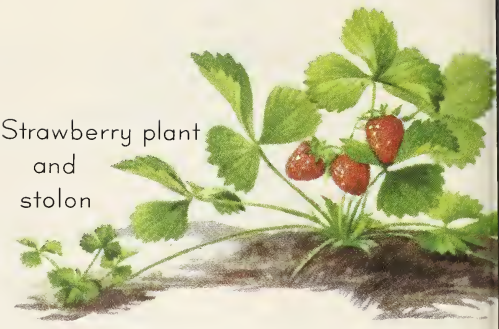
T.S.

Here is another way to use stems to grow new plants: Cut a bit of stem from a geranium or from a coleus or an ivy plant. Such pieces of stems are called cuttings.

Place the cutting in a glass of water. Keep it in a sunny place. Roots will grow from the cutting. When this new plant has many roots, you may want to put your growing plant into a flowerpot with sand and soil in it. The sand helps to keep the soil from packing around the roots.

Later on you should put your plant in good soil. The plant will keep growing for a much longer time in good soil.

African violet



Strawberry plant and stolon

It is fun to grow new plants from the traveling stems, or runners, of strawberry or raspberry plants. You may be able to get a strawberry plant with which to experiment. The plant will send out a traveling stem called a stolon. New roots and stems will grow on the stolon at every other joint. You can grow many new plants from one strawberry plant.

New plants sometimes grow from leaves. This is true of the African violet. If you buy one African-violet plant from the florist, in time you can grow many new plants from it.

Pick a leaf with the stem attached to it. Fill a dish with damp sand and push the stem of the leaf down into the sand. Cover the dish with a glass jar. Roots will grow down into the sand from the base of the leaf.

The leaves of the snake plant will also grow into new plants. Cut one leaf crosswise into several pieces. Stand each piece in damp sand and cover the pieces with a glass jar. New plants will form where the leaf touches the sand.

Another kind of plant that will grow from a leaf is the walking fern. The tips of some of the leaves of the walking fern bend over and touch the damp soil. They send down roots and form new plants.

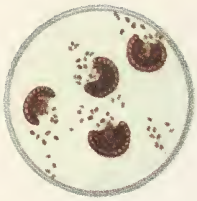
Growing Plants from Grafting

There is still another way to grow new plants. It is called grafting. Fruit trees are often grown in this way. Buds or stems from an apple tree that produces fine, sweet apples have been grafted to another apple tree whose fruit is not so sweet. Branches will soon grow, and the apples on these branches will be nice, sweet apples.

Rosebushes are also sometimes grafted. A cutting of one rosebush is sometimes fastened to the cut stem of another rose plant. The two will grow together. The cutting will use the roots of the old plant and can then bloom sooner. It does not have to wait for new roots to grow.

Grafting on an apple tree

Grafting on a rosebush



Spores

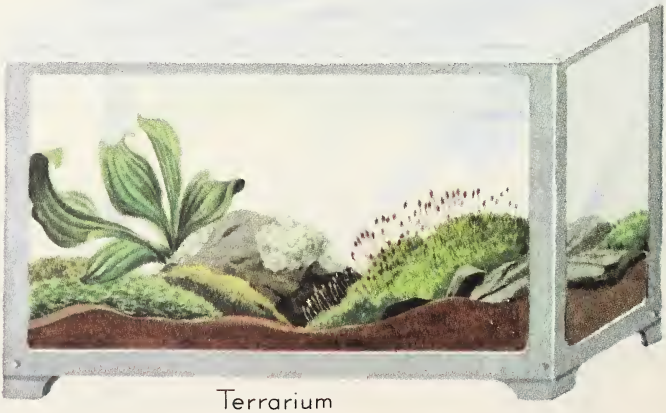
Growing Plants from Spores

Some plants have no flowers. These plants do not make seeds. They grow new plants in other ways. They grow new plants from tiny bits called spores. Most spores are so tiny that they can't be seen one at a time. They can be seen only through a microscope or when many of them grow together.

Spore cases

Ferns grow new plants from spores. If you can go to a woodsy place where ferns grow, you will see small yellow or orange or brown dots on the underside of some of the fern leaves. These are spore cases. Each case has many spores in it. If any of these spores fall where they can get warmth, air, and moisture, they will grow into small plants with tiny roots.

Mosses grow from spores, too. If you can bring some mosses into your classroom, you may be able to grow more mosses from the spores. Keep the mosses in a glass terrarium like the one in the picture below.



Terrarium

Have you seen mushrooms or puffballs? These are plants that grow from spores. After a wet season you often find mushrooms and toadstools growing on the school grounds or the lawn near your home.

There are millions of spores in the air all the time. They start growing into plants when they find a good spot in which to grow. They need damp and warm places in which to grow.

You can grow spores on a damp piece of bread if you wish. Leave a piece of bread outdoors all day. Then place the bread in a glass jar. Put a wet blotter in the jar, too. Then screw on the metal cover, so that the bread will stay damp.

Put the jar in a warm, dark place. Be sure to keep the blotter wet. After several days you will see blue and black mold growing on the bread.

You can grow another plant from spores. It is mildew. Dampen a piece of old cloth and roll it up in a piece of heavy paper for several days. Be sure the cloth stays damp. Put in a warm, dark place. After several days unroll it and see if there is mildew on it. Mildew is a plant that grows from spores.

YOU MAY WANT TO DO THESE THINGS

1. Look carefully at the pictures above and find the spore cases, ready to open and spread millions of spores, from which new plants will grow.

2. If there are wintergreen plants growing near you in the woods, you can start new plants from their underground stems. Do not bring more than one plant indoors. You may be able to watch new plants grow every few inches along the stem of your plant.

3. Go for a walk to a place where ferns and mosses grow. Look for the spore cases of these plants. Bring one or two of these cases back to school. Try to grow new plants from these spores.

4. Examine some cones from pine or spruce or other evergreen trees. Do not pick them off the tree. If the cones are green, they are closed. The seeds inside them are not ripe yet. When the cones turn brown, they will open. Then the ripe seeds will fall to the ground. Some of these seeds will grow into new evergreen trees.

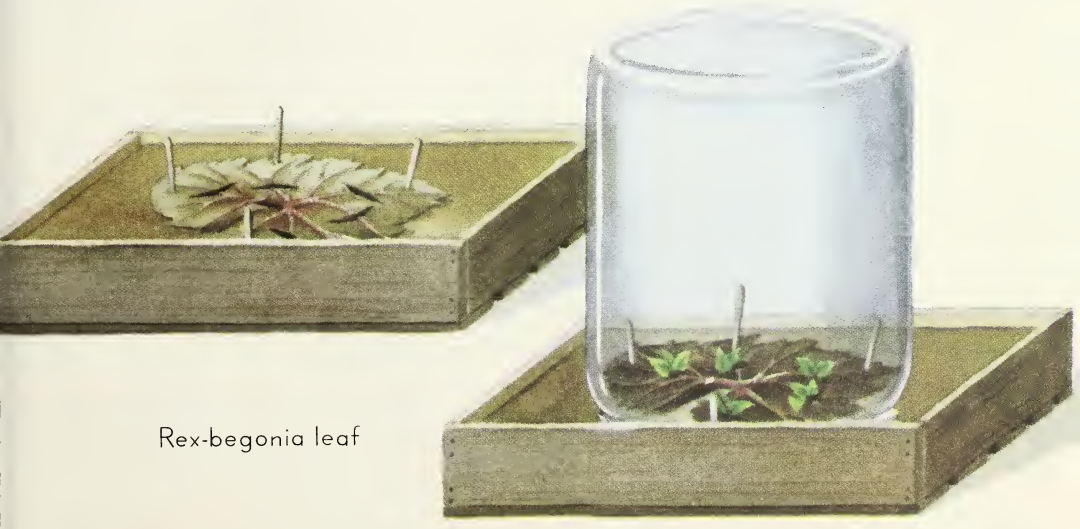
5. You may wish to see whether a new plant will grow best from seeds or from other parts of the old plant. You might try growing onions from seeds and onions from bulbs. You could grow a white potato from a piece of an old potato which has an eye in it. And you might like to grow a white potato from seeds. Potato seeds form on some old potato plants. They are called potato balls.

Keep a record of your experiments. Notice which plants grow best from parts of plants and which grow best from seeds.

6. If you cut a stem from a pussy-willow tree or a forsythia bush and put it in water, it will take root. Then you can plant it outdoors and watch it grow.

7. A rex-begonia plant can be grown from a begonia leaf. Cut the large veins which you see on the leaf. Lay the leaf underside up on damp sand. Peg the leaf down with toothpicks. Cover it with a jar to keep the moisture in and put it in a sunny place. New plants will grow where the veins of the leaf were cut.

8. Seeds are different in size and shape. They differ, too, in the ways they are spread about. Your class might like to make a study of the many ways seeds travel. If you take a walk in the park in the autumn, you may see that seeds travel in several ways. It may surprise you to learn of the many, many ways in which seeds travel. Make a list of them.



Rex-begonia leaf

Learning about Animals

Many Kinds of Animals

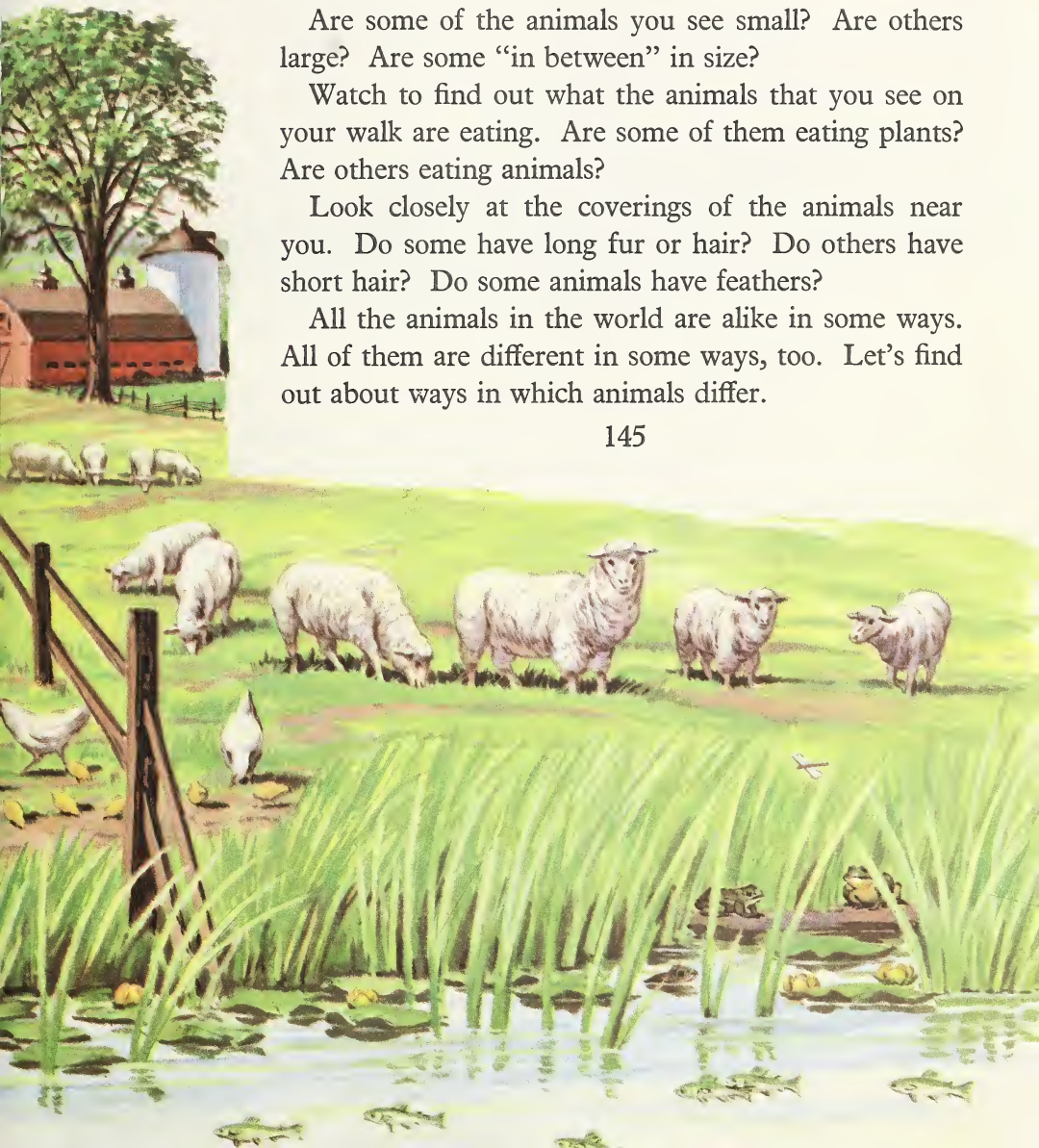
Take a walk around your neighborhood. You may be able to see many kinds of animals. Some may be crawling. Some may be flying. Are some walking? Are others swimming?

Are some of the animals you see small? Are others large? Are some "in between" in size?

Watch to find out what the animals that you see on your walk are eating. Are some of them eating plants? Are others eating animals?

Look closely at the coverings of the animals near you. Do some have long fur or hair? Do others have short hair? Do some animals have feathers?

All the animals in the world are alike in some ways. All of them are different in some ways, too. Let's find out about ways in which animals differ.



Earthworms

Some Animals Have No Bones

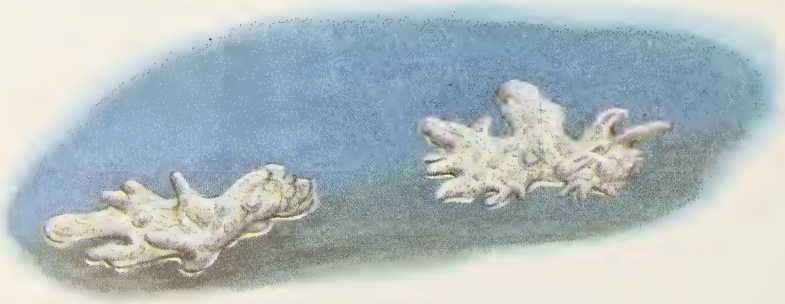
Have you ever watched an earthworm? It moves its body as it crawls about. When you put it on your fish-hook, it moves very fast. How soft it is! This is because it has no bones in its body.

The earthworm is one of the millions of animals that you know that have no bones. Some of this group of boneless animals are very tiny. Some are larger. All of them have soft bodies.

Many of these tiny animals cannot be seen unless you look at them through a microscope. Some of these tiny animals live in ponds and streams. Others live in sea water. Still others live in the soil. Sometimes some of these tiny animals get into our blood and make us ill.

An amoeba is a tiny animal. It is smaller than the period at the end of this sentence. It lives in moist places. It is one of the many, many small animals without any bones.

Tiny animals greatly enlarged



Sea Animals with Soft Bodies inside Hard Coverings

Many animals living in the oceans, lakes, and rivers belong to the group of animals that have soft bodies. This picture shows you some of the soft-bodied animals that live in salt water.

These water animals are protected by hard outside coverings. They are safe from many of their enemies when they are inside their hard coverings.

Notice that these animals do not look alike. They have different shapes. They are different in size and color, too.

However, they are all alike in one way. They have soft bodies inside their hard coverings.

Starfish are not fish. Sea cucumbers are not vegetables, and sea lilies are not flowers. They are all animals. Each one of these has a soft body inside a hard covering.

Sometimes you find the hard coverings of sea animals washed up on the shore. When a sea animal dies, the soft part of its body may be washed away by water. All that you find are the hard coverings of these animals.

The shells of many sea animals are very beautiful in color. It is fun to find them when you go to the beach to swim. Have you ever gathered shells at the beach?

People use many sea animals for food. Perhaps you have eaten oyster stew. It's good. Clams and crabs and scallops are good to eat, too. Have you ever tasted any of these kinds of sea food?

Have you ever watched a snail? It is an interesting animal. A snail has a foot, which it can stick out of its shell. It crawls along on this foot in search of food.

Sea snails and other water snails eat tiny plants and animals that they find floating in water or fastened to stones in the water.

The snail has only one part to its shell. This is true also of the sand dollar, abalone, and many other sea animals. Abalone shells are very beautiful. They are larger than clam shells. They are found along the Pacific coast.

Some other sea animals, such as scallops and oysters, have two parts to their shells. The two parts of the shell open and shut on hinges. They open, and the animal inside can get food and air and water. They close, and the animal inside is safe from many enemies.

Insects Have Soft Bodies, Too

Swat that fly! Kill that mosquito! Poison the fleas on your dog! Watch those busy ants building their homes. See the honeybee, with its legs full of pollen. Watch the beautiful moth coming out of its cocoon.

Animals, animals, animals! Millions of them! Flies, bees, beetles! Ants, butterflies, and moths! Let's take a look at some of them.

First, count the legs of each one. One, two, three, four, five, six legs. Yes, that's one way in which these animals are alike. Each one has six legs.

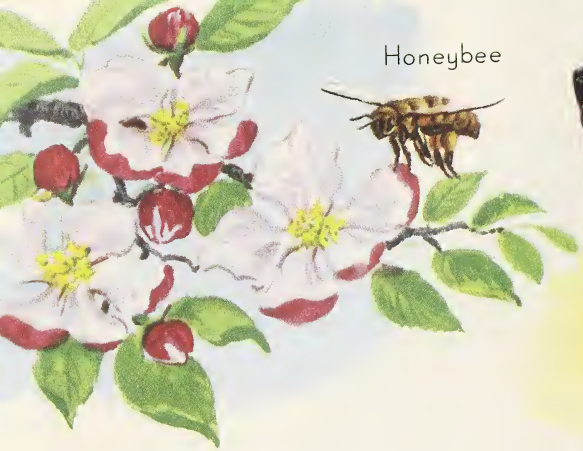
Now count the parts of the body of each one. Can you find three main parts to each body? First, find the head. Next find the middle part of the body. This part is the thorax. Now find the third part. This part of the body is the abdomen.

Wasps

Mosquitoes

Moths

Ants



Honeybee

Black swallowtail butterfly

Tumble bug

Now look carefully at the two feelers, which stick out of the sides of the heads of these animals. Can you find them?

All the animals pictured above are alike in certain ways. They all have six legs, three body parts, and feelers. Whenever you find other animals like these, you will know they belong to the same group. They are called insects.

There is still another way that these animals are alike. They have coverings on the outside of their soft bodies.

Some have harder coverings than others. The coverings of mosquitoes and moths are thin and not so hard as the coverings of many kinds of beetles.

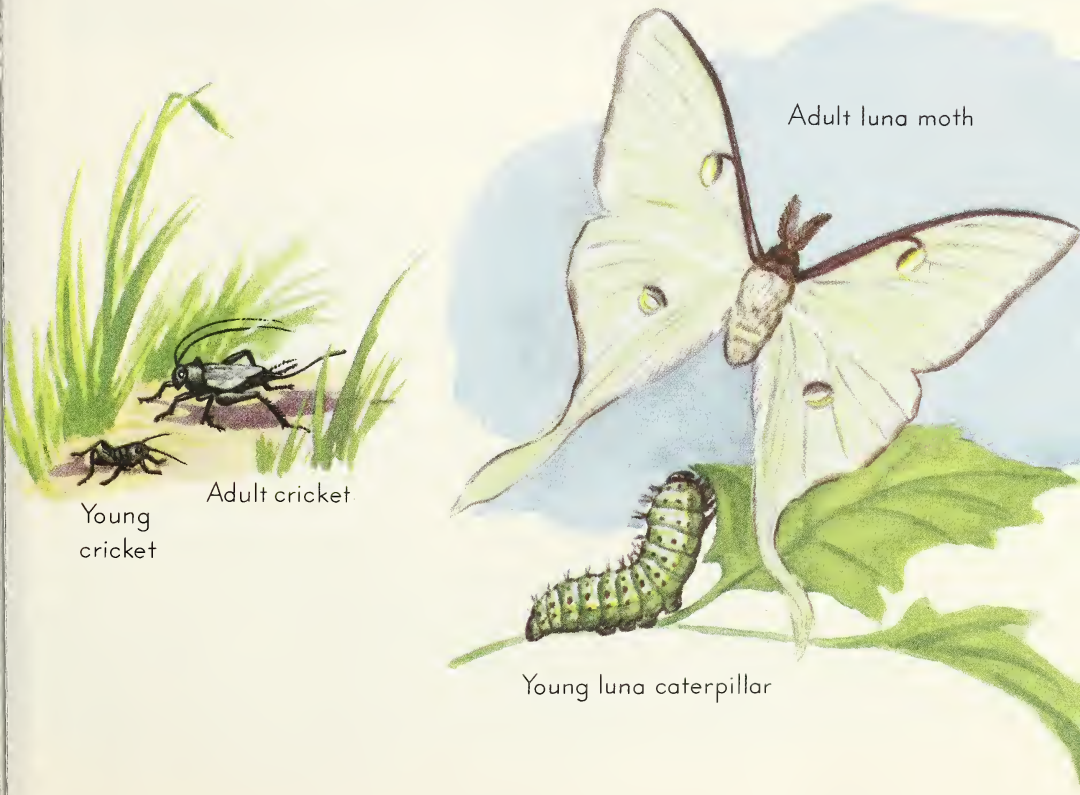
The world is full of insects. They are found almost everywhere. They can live in hot places and in cold places. Many live in water. Many live on land.

Some insects look much the same when they are young as when they are grown up. Young crickets look much like grown crickets. Of course they are small when they first hatch from eggs, and they have no wings.

Some young insects change their looks as they grow. Young moths and butterflies change as they grow. When they are first hatched, they look like worms. They eat and eat. Then they go into a resting stage.

Now changes take place. These changes take place inside a case, or covering, that each insect makes for itself. Grown-up moths and butterflies finally come out of these cases. The grown-up insects have wings, three body parts, six legs, and two feelers.

So far you have been reading about soft-bodied animals. All insects belong to this group of animals. Millions of other tiny animals are also part of this group. Many sea animals belong to this large group of animals, too.



Animals with Skeletons

All the animals you have been reading about are alike in at least one respect. They all have no bones in their bodies. Now let's read about another large group of animals.

These animals are alike in at least one respect, too. They all have bones in their bodies. You will read about frogs, fish, snakes, and lizards. You will read about ducks, turkeys, and robins. You will read about skunks, pigs, and cats.

These all belong to the group of animals that have bones. The bones are joined together into a framework, which holds up their soft bodies. This framework is called the skeleton of the animal.

How Are Fish Alike?

Have you ever watched your father clean a fish? Did you see the backbone of the fish? This is part of the skeleton of the fish. Almost all the other bones of the fish are joined to it.

No matter what kind of fish your father is cleaning, it will have a backbone and other bones joined to it. This is the framework of the fish. All the bones of the fish make up its skeleton.

Fish are alike in other ways too. They can live only while they are in water. They die soon after they are brought out of water. Fish can breathe only in water. They breathe through gill slits, which are on each side of their heads.

Water has air in it. A fish gets air for breathing from the water. Water goes in through the mouth of the fish. As it flows out over the gills, the fish breathes the air that is in the water.

There are other ways in which fish are alike. Almost all fish are covered with scales. All of them have fins and a tail.

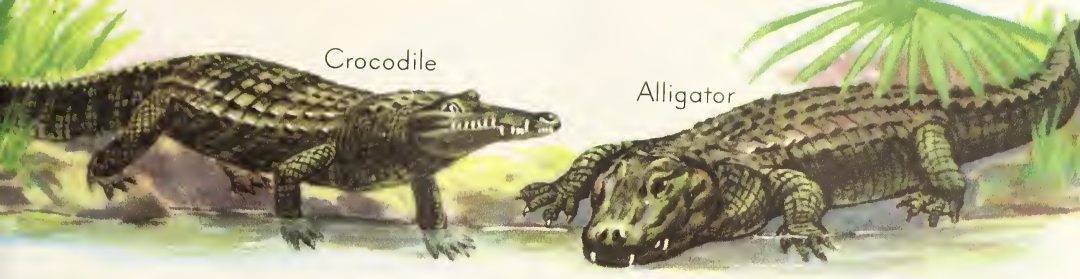
There is still another way that all fish are alike. They are all cold-blooded animals. This does not really mean that their blood is cold all the time. Sometimes, however, their blood is colder than ours.

The blood of cold-blooded animals is usually about the same temperature as the air or water in which they live.

If the air or water becomes colder, then the blood of the animal becomes colder. If the air or water becomes warmer, then the blood of the animal becomes warmer.

So, you see, cold-blooded animals might be called by another name. They are, too. They are often called variable-temperatured animals because the temperature of their blood varies, or changes.

Now do you see how fish are alike? They live in water. They all breathe through gills. Their blood changes temperature. They all have skeletons.



What Are Reptiles?

There is another group of animals called reptiles. Do many of them live near you? Do any snakes live nearby? Do you ever see any turtles crawling around your schoolyard? Do you live near places where alligators or crocodiles live? Are there any lizards near your home?

All these animals are reptiles. The animals of this group are alike in certain ways. In the first place, they are all cold-blooded animals, just as fish are.

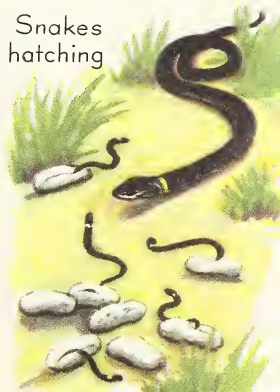
In the second place, their bodies are usually covered with scales or a hard shell, and they have skeletons. Every turtle you are likely to see has a hard shell. Every snake you will see has scales. Every alligator has thick, strong scales. Also, each of these animals has a skeleton inside its body.

Reptiles are all alike in another way too. They breathe with lungs, much as we do. Many of them live both in and out of water. But they cannot breathe under water. They have to keep their noses above water much of the time in order to breathe.

Perhaps you have seen only the head of a turtle sticking out of the water. Now you know why this is necessary. A turtle must come to the top of the water to breathe air.

Spotted lizard

Painted turtle


Snakes hatching

Learning about Amphibians

Red eft

The animals pictured on this page all belong to the same group. They are all amphibians. These animals belong in a group by themselves because their bodies change so greatly as they grow up.

Amphibians look one way when they are young and another way when they grow older. They live in the water when they are young. They breathe through gills then. Later on they change. Then they can live on land and breathe through lungs, just as reptiles do.

Frogs lay their eggs in water. Have you ever seen a jellylike mass of frog's eggs in water? The young that hatch from these eggs are called tadpoles.

Newt

Spotted salamander

Toad croaking

Mud puppy

Frog

Tadpoles grow up

Frog's eggs

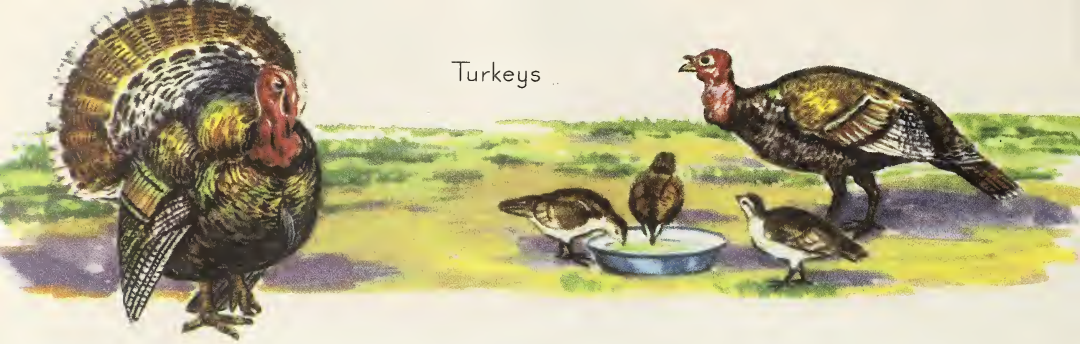
As tadpoles hatch, they swim about in fresh water. They keep growing. The picture on this page shows you how they change as they grow. Look carefully and point out the changes that take place as frogs grow.

Toads lay their eggs in water, too. Have you ever seen eggs like the ones in this picture? These are toad's eggs. They hatch into tadpoles. Tadpoles swim around in the water and eat and grow larger. When they change from tadpoles to toads, their way of breathing changes. Now they no longer live in water. They live on land and breathe with lungs.

You may find toads in your garden. They eat many insects that harm garden plants. Always welcome toads in your garden. They are your helpers.

Amphibians are alike in other ways. They are cold-blooded animals, just as reptiles and fish are. They have skeletons inside their bodies. They have skin instead of scales.

Toad's eggs



Turkeys

Birds Are Warm-blooded Animals

Duck

The animals you have been reading about move in many ways. Some hop. Some walk. Some crawl. Some fly. Birds are like some insects in the way they move. Most birds fly, too.

All birds have two wings and two legs. Some birds are great fliers. Many of them travel long distances. On the other hand, some birds fly but little and others not at all, even though they have two wings. Penguins and ostriches cannot fly at all.

Goose

Many children are surprised to learn that chickens, turkeys, geese, and ducks are birds. We get used to thinking of birds as wild animals that fly a great deal. We forget that tame birds can fly, too.

If you live in the country, your mother may sometimes chase the chickens or turkeys out of the garden. She says, "Shoo, shoo!" Away they fly out of the garden. But they fly only a short distance even then. Many times they only spread their wings and run. Can you guess why?

Hen

Birds are alike in another way. They are warm-blooded animals. This means that their bodies are always about the same temperature. They do not change temperature as cold-blooded animals do.

A bird's body does not become colder when the air around the bird becomes colder. The body does not become warmer when the air around the bird becomes warmer.

A bird has about the same temperature all the time, unless it becomes ill. Then it may have a fever, and the temperature will be higher.

Normal bird temperature is higher than your normal temperature. When you are well, your body temperature is between 98 and 99 degrees. Normal bird temperature is between 102 and 110 degrees.

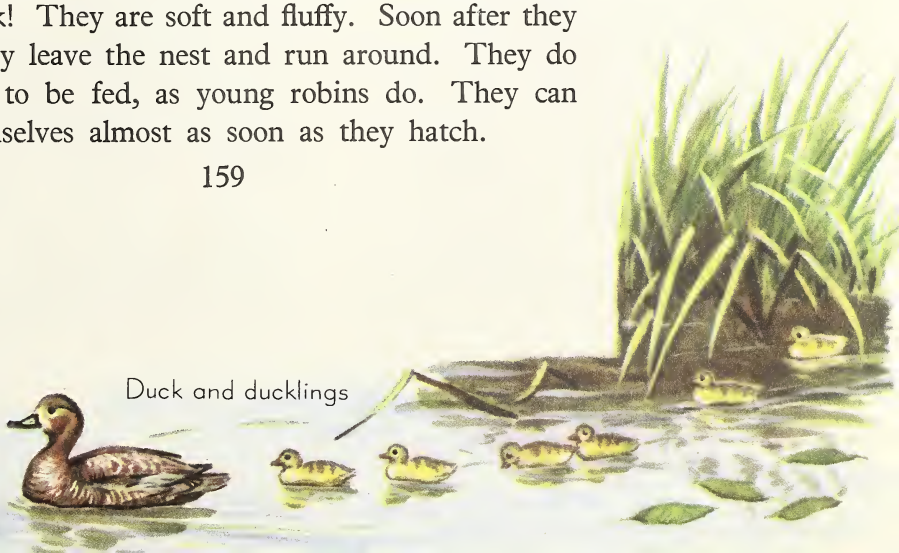
Sometimes we speak of warm-blooded animals in another way. We say that they are constant-temperatured animals. We say this because their body temperatures stay about the same all the time.

There is one special way that birds are different from all other animals. They have feathers. No other kind of animal on earth has this kind of covering.

Have you ever seen very young robins being fed? They are so helpless. They have only a little bit of fuzz covering their skins. As they grow older, the fuzz gets all covered up by feathers. How different young ducks look! They are soft and fluffy. Soon after they hatch, they leave the nest and run around. They do not need to be fed, as young robins do. They can feed themselves almost as soon as they hatch.

Young robins being fed

Duck and ducklings



What Are Mammals?

The animals pictured on this page belong to the same group. They are all mammals. Mammals are like many other animals because they have strong skeletons. In this respect they are like frogs and birds and snakes.

All mammals are like birds in one way. All birds and mammals are warm-blooded animals. Their body temperatures do not change as the temperature of the air or water around them changes. The body temperature of dogs and cats, robins and kingfishers, stays about the same all the time.

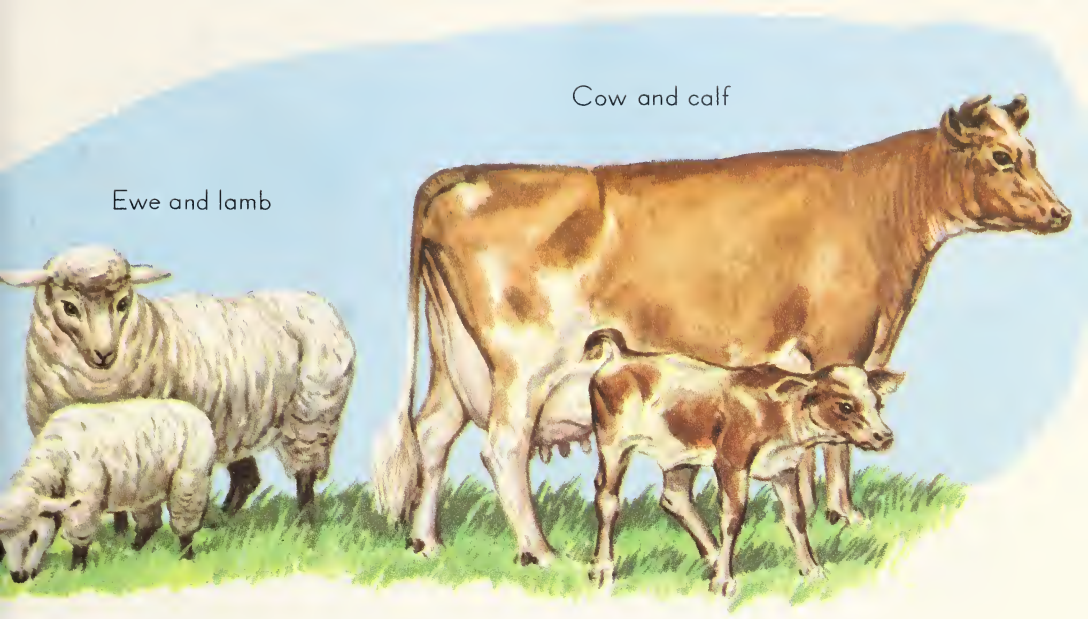
Mammals, however, are different from birds in one very special way. Young mammals feed upon milk from their mothers' bodies.

Have you seen young kittens or puppies getting milk from their mothers? Have you seen a young colt or a young calf getting milk from its mother?

Elephants, whales, bears, deer, and rabbits are all mammals. The young all feed upon their mothers' milk. Can you name other animals in this group?

Dog and puppies

Rabbit and young



There is another way in which you can know mammals. They have hair on their bodies. Sheep have woolly hair on their bodies. Horses have long manes of hair on their necks and shorter hair all over the rest of their bodies. Cows, seals, and dogs have hair on their bodies, too.

Think of the animals you have seen in the zoo or in the circus. Can you tell which animals belong to the mammal group? Do tigers and lions have hair? Do monkeys and wolves have hair on their bodies? What other animals do you know that have hair on their bodies?

The young of most mammals are born alive. They are not hatched from eggs, as birds, frogs, and lizards are. Many of the young mammals are helpless when they are first born. They need good care. They need protection and food and a nice warm place to sleep.

Have you ever seen young puppies sleeping very close together at the side of their mother? The heat from their bodies helps to keep all of them warm as they sleep. Have you seen young kittens or pigs sleeping in much the same way?

Some young mammals are carried around by their mothers until they are old enough to take care of themselves. The picture shows you how a young kangaroo is protected while it is young. How should you like such a pouch in which to travel?

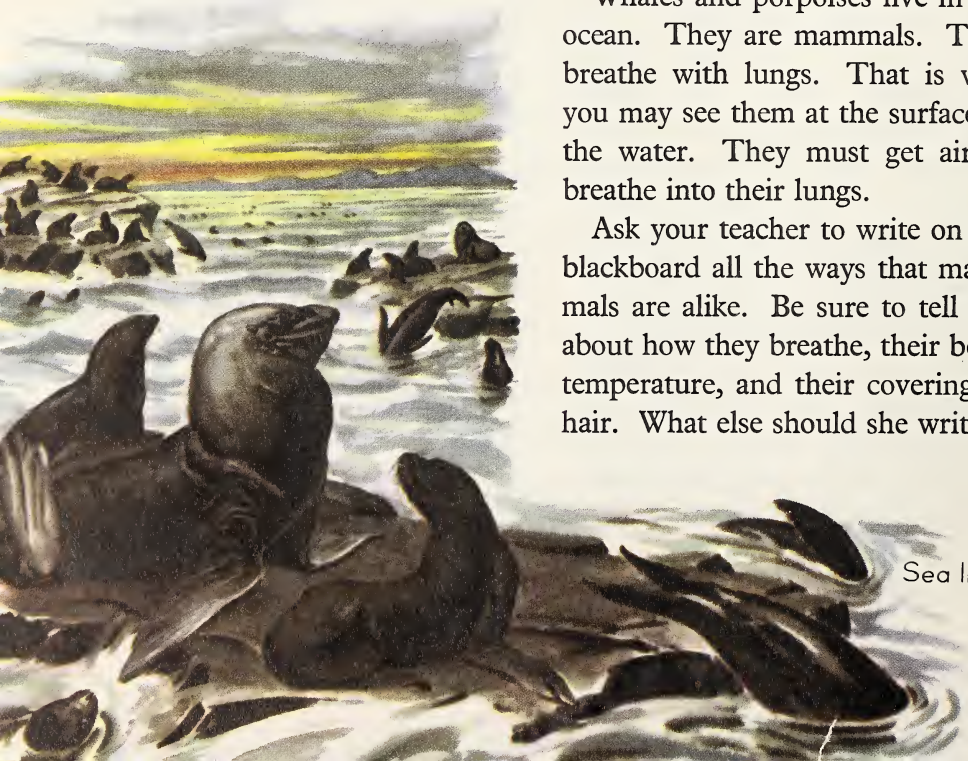
Most mammals are land animals. Seals and walruses and whales, however, are mammals, too. They live in water. But they must come to the surface to breathe. They breathe with lungs.

Kangaroos

What fun it is to watch a sea lion swimming in its pool! A sea lion is a kind of seal. You will notice that every few minutes it comes to the top of the water. It sticks its nose above the surface. It breathes that way.

Whales and porpoises live in the ocean. They are mammals. They breathe with lungs. That is why you may see them at the surface of the water. They must get air to breathe into their lungs.

Ask your teacher to write on the blackboard all the ways that mammals are alike. Be sure to tell her about how they breathe, their body temperature, and their covering of hair. What else should she write?



Sea lions

1. Divide into groups in your class. Each group may then make a chart or a booklet about an animal group. Be sure one group of children takes reptiles, another birds, another mammals, and so on. You may wish to list some of the animals that belong in your group. You may wish to list ways in which all animals in your group are alike. You may wish to draw pictures and write stories about how certain animals live. Tell about how they grow up, what they eat, and where they live.

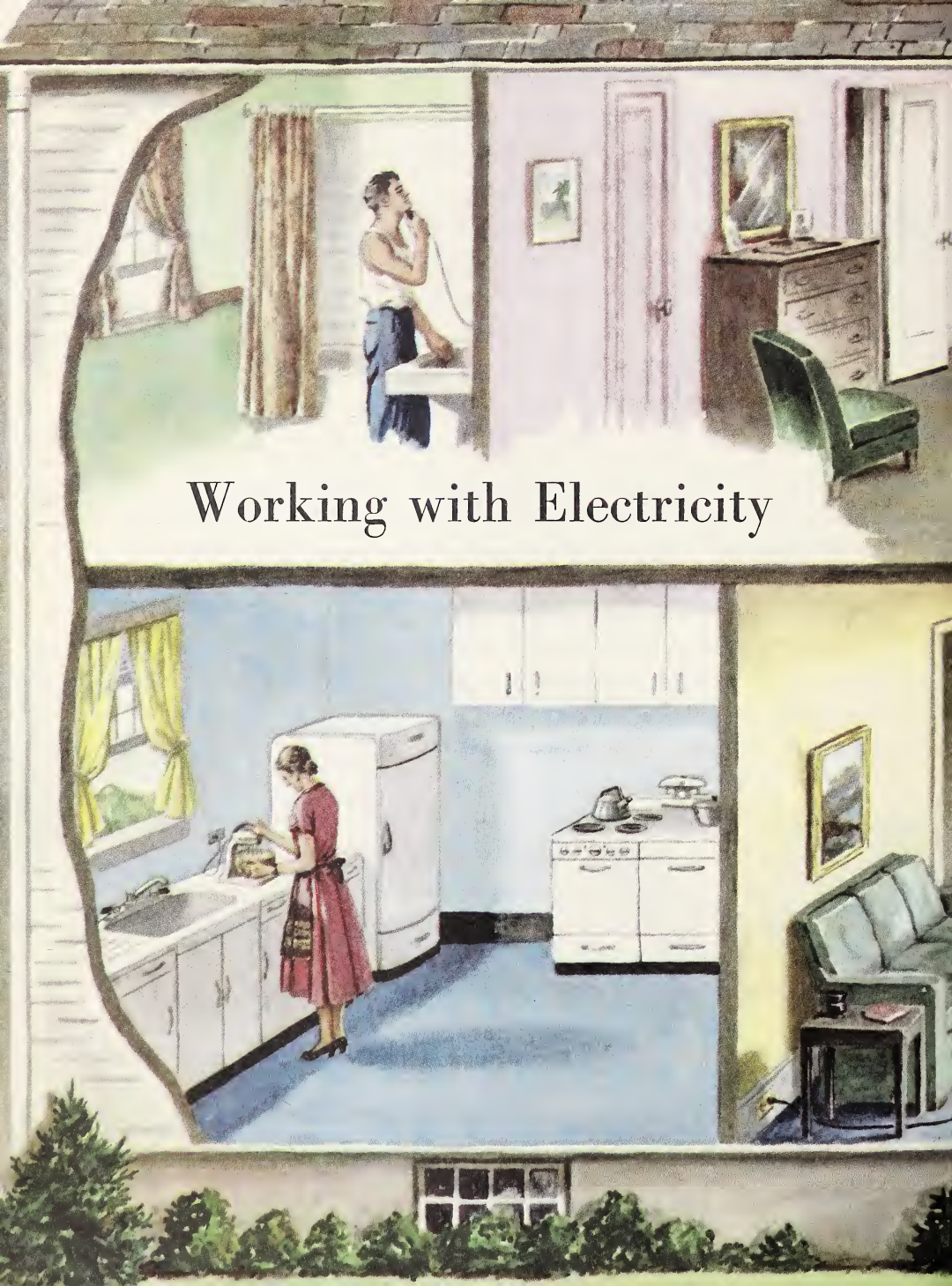
2. Snakes live in many places. Most of them are harmless. In fact, most of them are very helpful animals. They eat mice and other animals that are pests. There are only a few kinds of poisonous snakes in North America. You should learn to recognize these snakes, so that you can protect yourself from them. The pictures on this page show you what they look like. Study them with care.

Diamondback rattler

Coral snake

Water moccasin

Copperhead

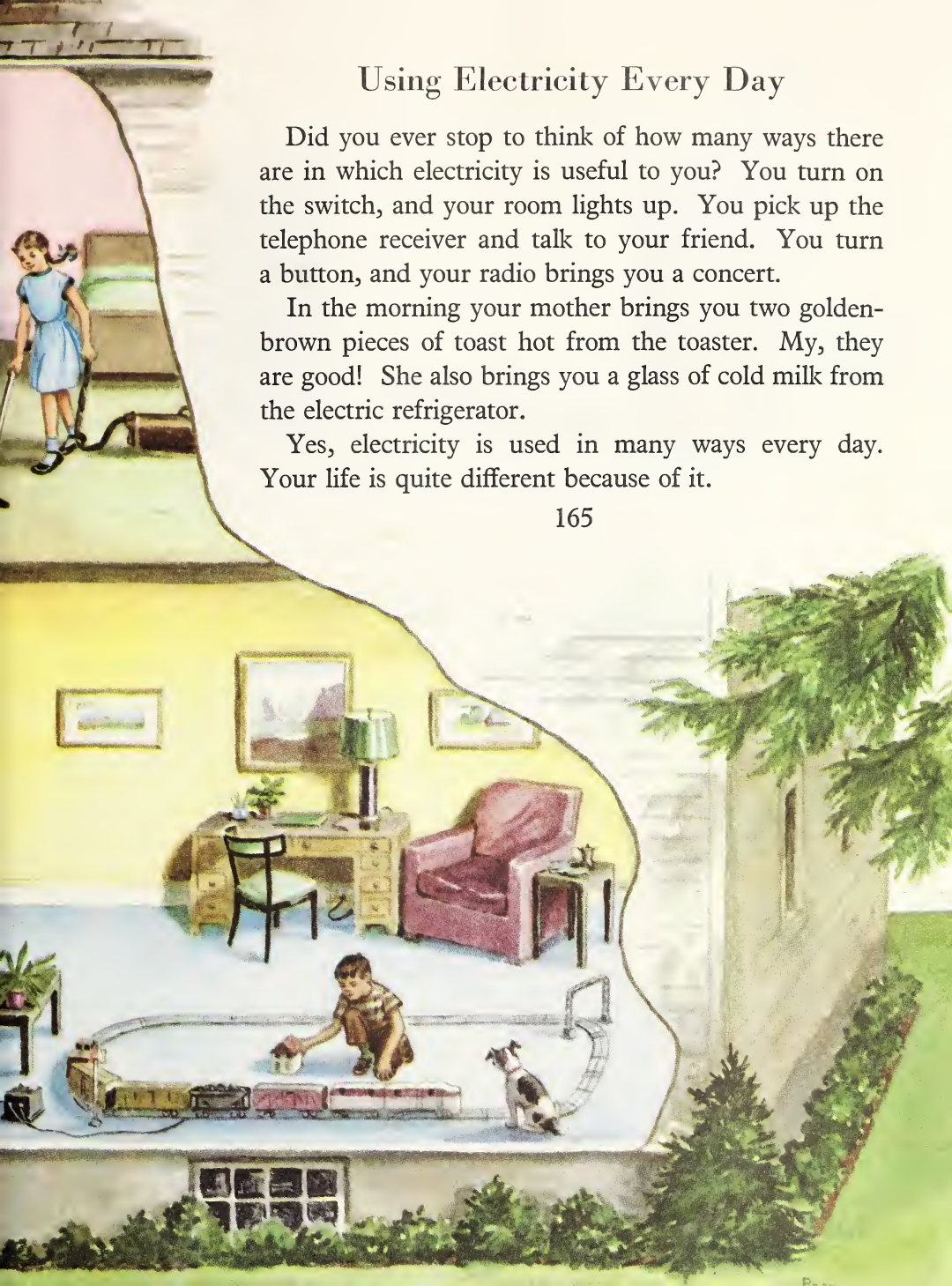

Working with Electricity

Using Electricity Every Day

Did you ever stop to think of how many ways there are in which electricity is useful to you? You turn on the switch, and your room lights up. You pick up the telephone receiver and talk to your friend. You turn a button, and your radio brings you a concert.

In the morning your mother brings you two golden-brown pieces of toast hot from the toaster. My, they are good! She also brings you a glass of cold milk from the electric refrigerator.

Yes, electricity is used in many ways every day. Your life is quite different because of it.



Outside of a dry cell

Inside of a dry cell

What's inside a Dry Cell?

You can learn a great deal about electricity by working with it at school. You will use a dry cell in your work. A dry cell makes only a little electricity at one time.

It is safe for you to work with electricity made inside a dry cell. There is not enough electricity made in one dry cell to harm you.

Did you ever wonder what a dry cell looks like inside? Have you ever opened one to see? Some children think there is electricity inside a dry cell. Let's open one and look inside.

You will need a hammer or a can-opener, a chisel, and a saw. You will need some big sheets of newspaper too. Open your dry cell on a newspaper. This will make it easier to clean up after your work.

First, take the paper off the dry cell. This outside paper cover protects the dry cell.

Now comes the hard work. Cut the metal can down the side. Use your hammer and chisel or your saw to do this. The metal can is made of zinc. This metal can is useful in making electricity.

All around the inside of the metal can you will probably find some moist blotting paper. And then you will see a black, powdery paste. Right down through the center of the dry cell you will see a black carbon rod.

At the top of the dry cell are two connecting screws. One screw is fastened to the zinc can. The other is fastened to the carbon rod.

The top of the dry cell is sealed. This is to keep the inside of the dry cell from really becoming dry. The black, powdery material stays moist.

The black, powdery material is a mixture. It is a chemical mixture. The chemicals touch the carbon rod and the zinc can.

But where is the electricity? The dry cell is apart, and there is no electricity inside it.

Dry cells do not store electricity inside them. They make, or produce, electricity only when a complete path is provided along which the electricity can move. Then the chemicals and the carbon rod and the zinc can, all working together, set electricity free.

Zinc can

Carbon rod

Black, powdery material

Paper lining

Making a Path for Electricity

You will want to know how to make a path so that a dry cell can make electricity move. The picture shows you how to make such a path.

The wire you will need is called bell wire. This is copper wire. The dry cell is a No. 6.

Do you see that the ends of the wire are bare? Scrape the covering off both ends of the wire you are using. Connect the two ends of the wire to the two screws, or posts, of the dry cell. Now you have made a path, or circuit. The materials inside the dry cell begin to work together to make electricity move along the path, or circuit.

The electricity travels out of the dry cell through the copper bell wire and back into the dry cell again. There is a complete path, or circuit, through which the electricity can travel. Can you point out this complete circuit? Use your pencil to follow the path.

You will want to remove the wire from the posts as soon as possible. The wire will get very warm if you leave it connected. There might be danger of your burning yourself. You should remove the wire also so that your dry cell will not wear out.

Making a Bell Ring

You may want to use the electricity that the dry cell is setting free. You can use it to ring a bell.

This time use two pieces of bell wire. Fasten one end of each wire to a screw of the dry cell, as shown in the picture below. Be sure to fasten the ends well. You want them to be fastened tight in order to make a good path along which electricity may move.

Now fasten the free end of each wire to a post of the bell. Does your bell ring?

This time you have made the *bell* part of the circuit. Now electricity travels from the dry cell through one wire to the bell. Then it travels through the bell and back to the dry cell again through the other wire. It travels along the whole circuit.

Making a Bell Stop Ringing

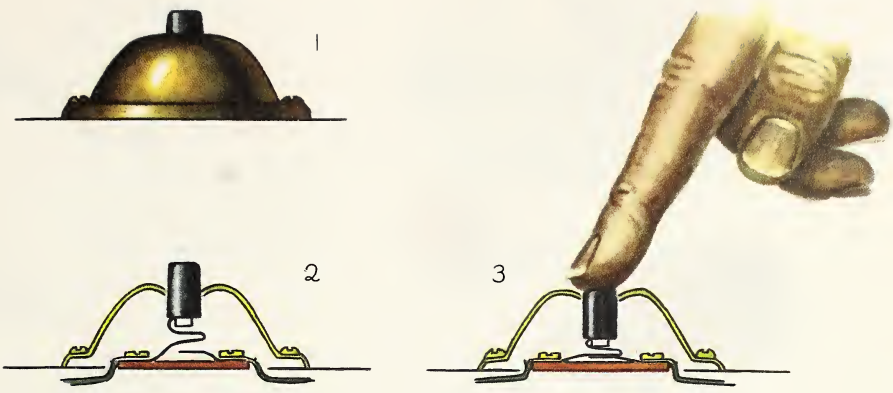
Of course you don't want the bell to keep on ringing and ringing. Let's stop it. Take either end of a wire away from the screw to which it is fastened, and the bell will stop ringing. Fasten it again. The bell will begin ringing all over again.

What a bother it is to fasten and unfasten the wire! It takes so long. Here is an easier way to do it: Use a push-button switch.

Cut one of your wires in two. Scrape a little covering off the two cut ends of the wire. Fasten these ends to the screws of the push button.

Now press the button down with your finger. The bell rings. Take your finger away, and the bell stops ringing.

This time you have made the *push button* a part of the circuit. Why, then, does the bell ring only when you push the button down? Let's look inside and see.



What's inside a Push Button?

The pictures on this page show you how a push button works. The first picture shows the outside of it. The second picture shows you what is inside a push button. The third picture shows you what happens when you push the button down.

When you push down on the button; you make a complete circuit. You push the brass spring down, and a piece of metal on it touches the metal below. Electricity can now travel through the circuit you have made. It goes along the copper wire through the push button into the bell and back to the dry cell again.

When you take your finger away, the piece of metal on the brass spring no longer touches the metal below it. There is now no path for the electricity to travel through. We say the circuit is broken. The bell stops ringing.

Poor conductors

Good conductors

Paths for Electricity

Some things make good paths through which electricity can move. You have been using copper wire for your experiments. We say copper is a good conductor of electricity because electricity can travel through it more easily than through other materials.

Many metals are good conductors. Iron and steel are good conductors. Your scissors and jackknife are good conductors. Your mother's darning needle will conduct electricity.

Fortunately for us, many things are poor conductors of electricity. An electric current cannot travel easily through air. Air is a poor conductor.

Electricity cannot travel easily through rubber or leather or wood or glass. Objects made of these things are poor conductors of electricity.

You can be a path for electricity. That is why you should know how to use it safely.

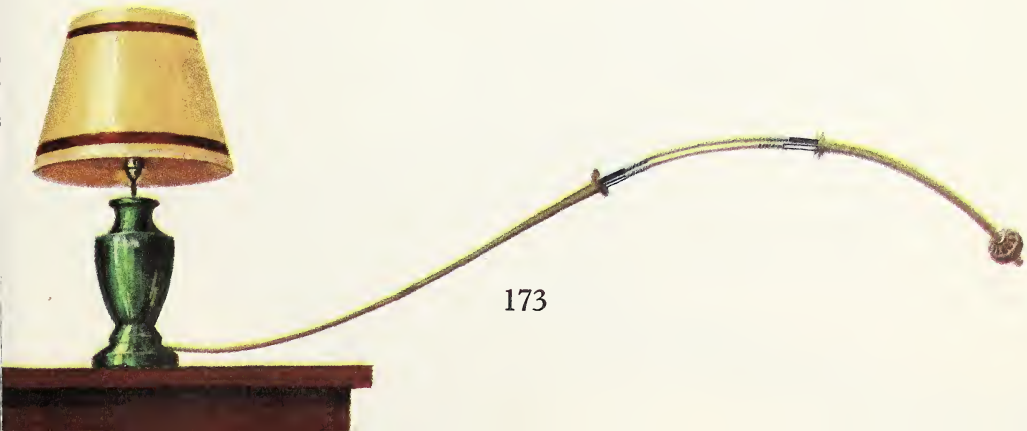
The dry cells you use at school are not dangerous. They do not make enough electricity to give you even a little shock. You need not be afraid to use dry cells for your experiments.

The electric current that lights your home is very strong. If you touched the bare wires that carry your house current, the electricity would travel through your body. You could get badly shocked. So do not touch bare wires that carry your house current. It is very dangerous to do that.

Let us see how electric cords are made to protect you from danger. Look at the cord of your electric toaster or floor lamp. Pick it up and notice how it is made.

The outside covering of your cord may be cloth or plastic or rubber. These coverings are poor conductors of electricity. We call poor conductors insulators. We say we use insulated wire for electric cords.

The inside of your cord is interesting. Look at the picture below. You see there are two wires inside your cord. Each wire is covered with material that is a poor conductor of electricity.



When you worked with dry cells, your two wires were separate. But the wires in your electric cords at home are wrapped together. They look better that way, and they do not tangle as easily. They are safer too, for there is a double layer of insulation around them.

Suppose you saw an old electric cord that looked like the one in the picture above. Would it be safe for your mother to use? What should be done about old and worn cords at home?

Are there some electric cords in your home that are covered with plastic or rubber? These coverings are waterproof. Do you know why it is a good idea for the coverings of electric cords to be waterproof? The reason is that water is a good conductor of electricity.

Notice the electric cord on your mother's washing machine. You will find that the insulation on this cord is of waterproof material. It is safe for your mother to use this cord when she is washing the clothes. If the cord gets wet by mistake, this covering keeps the water from getting inside the cord. If there were no such waterproof covering, the electricity might travel out of the wire through the wet insulation. The electricity would go into your body if you happened to touch the wet cord.

Always be sure that your hands are dry when you turn on a light or touch an electric appliance. Now that you know that you can be a path for electricity, will you be more careful?

What Is a Short Circuit?

Here is another thing we should remember about electricity: it always travels along the easiest path. That is another reason why electric wires are insulated. Insulation keeps the electricity inside the wire, where it should stay.

Sometimes the insulation wears off a wire. Then there may be trouble. The picture shows you what may happen. The bare wires may touch each other and become very warm. This is a short circuit.

Look carefully at the wires in the picture. Can you see that they touch each other at the place where they are bare?

Now look at the light. It isn't on. And no wonder. The electricity is traveling along an easier path. It isn't traveling into the light. It is only going to the place where the bare wires touch each other and then back to the dry cell again. The electricity travels along the short path. We say there is a short circuit.

Using Electricity to Make a Magnet

Do you know that you can make a magnet by using electricity? It is a special kind of magnet. We call this special kind of magnet an electromagnet. To make one, you should first find a large nail. Get as big a nail as you can. The bigger it is, the better.

Now wind a long piece of covered wire around your nail. Leave some wire at each end. Scrape the insulation off the ends of the wire and connect the bare ends to your dry cell.

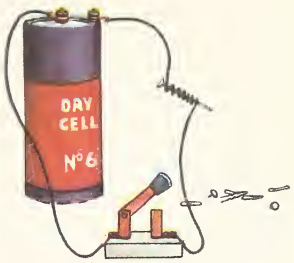
Your electromagnet can now be used to do work. Hold a paper clip near the end of the nail. What happens? Try a bobby pin. Will it pick that up, too? Try a thumbtack. What happens?

You have made the nail into a magnet by using electricity. You have made a path, or circuit, along which electricity can move easily. The electricity traveling through the coil of wire makes the nail into an electromagnet.

Now break the circuit by taking one end of the wire away from the dry cell. What happens? Will the nail pick up paper clips or thumbtacks or bobby pins now?

The nail is no longer an electromagnet, because no electricity is traveling through the wire. It is just a plain nail again. Or, anyway, it will soon be. Right at first the nail may keep a little magnetism. It may keep enough to hold one paper clip for a short time.

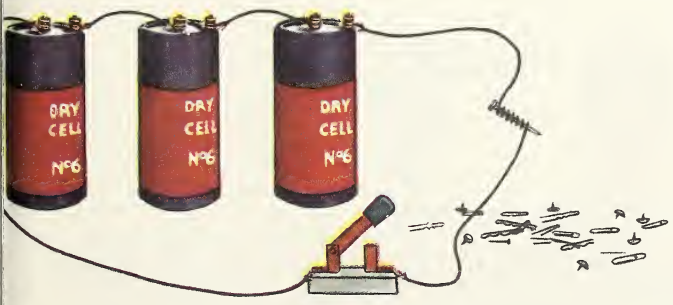
You may wish to add a switch to your circuit. Then you can turn the electromagnet on and off easily. Do it just as it is done in the top picture on this page. The switch in this picture is called a knife switch because it closes like a jackknife. But you might use any other kind of switch instead.

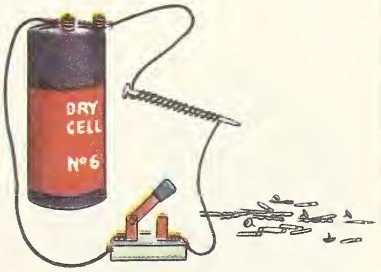


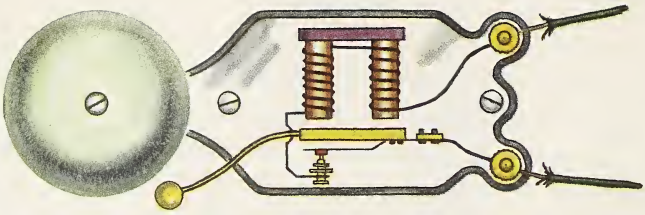
Now do some work with your electromagnet again. You can do this by closing the knife switch. This completes the circuit. Electricity moves through the wire and makes the nail into a magnet. Try to pick up many things with it.

Whenever you wish, you can open the switch. Now try again to pick up, with your electromagnet, all the things which you picked up before. What has happened? The nail is no longer an electromagnet, because you broke the circuit when you opened the knife switch.

You may want to make a stronger electromagnet. The pictures on this page show you two ways to do it. Try each way and see for yourself how to make a stronger electromagnet.







Where Do We Use Electromagnets?

Now that you know how electromagnets are made, you may wish to find out about their use. Are they any good? Where do we use them? Let's look inside an electric bell.

Can you see the two spools of wire? Do they remind you of the wire that you wound around the nail to make your electromagnet? That's what they are, an electromagnet. They are the electromagnet in your bell.

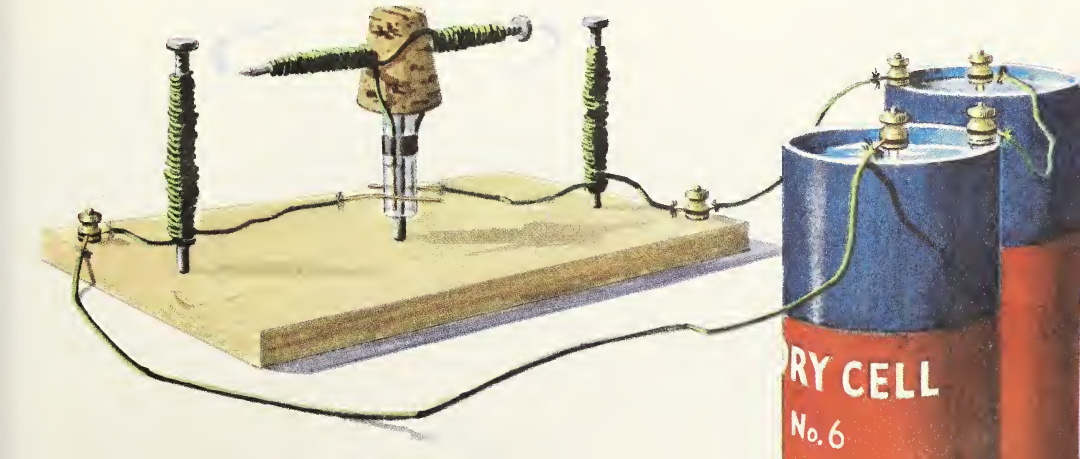
Many electric things you use today work because there is an electromagnet inside them. Your mother may use an electric mixer when she is making a cake for you for your birthday. She may also use it to mash potatoes.

You may have a motor that came with your toy building set. You may use your motor to lift objects or to pull trucks.

Perhaps your father has a motor on his workbench. He may run many of his tools with it. He may use it for sawing wood or making furniture.

Below is a picture of a motor that some children made. Can you find the coils of wire? They become electromagnets when electricity travels through them. They make the motor run.

Yes, there is always an electromagnet inside each electric motor. That is what makes the motor run.



Bob and Nancy have made a simple telegraph set. Their set has an electromagnet in it. Each time Bob presses on the key, the circuit is completed. The electromagnet attracts a piece of metal, and this makes a clicking sound. By means of these clicks Bob is sending a message to Nancy.

These men are using an electromagnet in their work. The big, round piece of metal on the end of the crane is an electromagnet. With it the operator picks up heavy pieces of iron and loads them into a flatcar.

THINKING ABOUT ELECTRICITY

1. Sometimes we forget that the use of electricity has changed our ways of living. Make a chart showing ways of living before electricity and now.

Now	Before electricity
Electric lamp	
Electric stove	
Electric toaster	
Electric washer	

2. Mary's family has just moved into a new home. Mary told her friends that the new house was completely modern. She said, "Almost everything works by electricity." What did Mary mean by her statement?

3. Look inside a flashlight. Can you trace the circuit in it?

4. Ask your father to take you to the garage or filling station when he is going to have water put in the car battery. The battery makes electricity. The battery uses chemicals to make the electricity that starts your car and lights its headlights.

5. Electricity is a kind of energy that is used to do work. It is used to run trains. It is used to run washing machines, in which your clothes are washed. It is used to run the vacuum cleaner, which helps you to get your rugs clean. All of us use energy from electricity to do much work for us.

6. Some of the items listed below are good conductors of electricity. Others are poor conductors. Make two lists, showing good conductors in one and poor conductors in the other.

cloth	plastic	straw	silver
brass	aluminum	glass	rubber
copper	feathers	silk	wood

7. Here are some rules for safety. Why are they good rules?

Do not touch loose wires hanging down from buildings or poles. If you should see a wire hanging in this way, you should tell a grownup about it at once.

Be sure to keep all cords used on electric appliances in good repair.

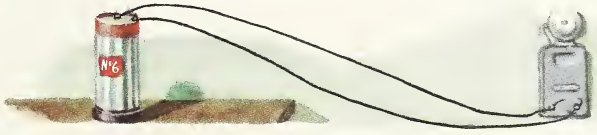
Be sure that your hands are dry whenever you touch an electric-light switch.

Use dry cells whenever you want to make the electricity you use in your experiments.

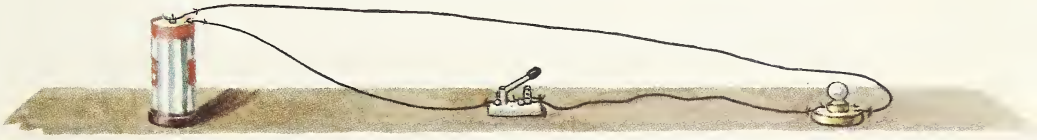
8. Can you find the fuse box in your home? Try to find out what fuses are for.

9. Thomas Edison made the first successful electric-light bulb. Read about how he did it.

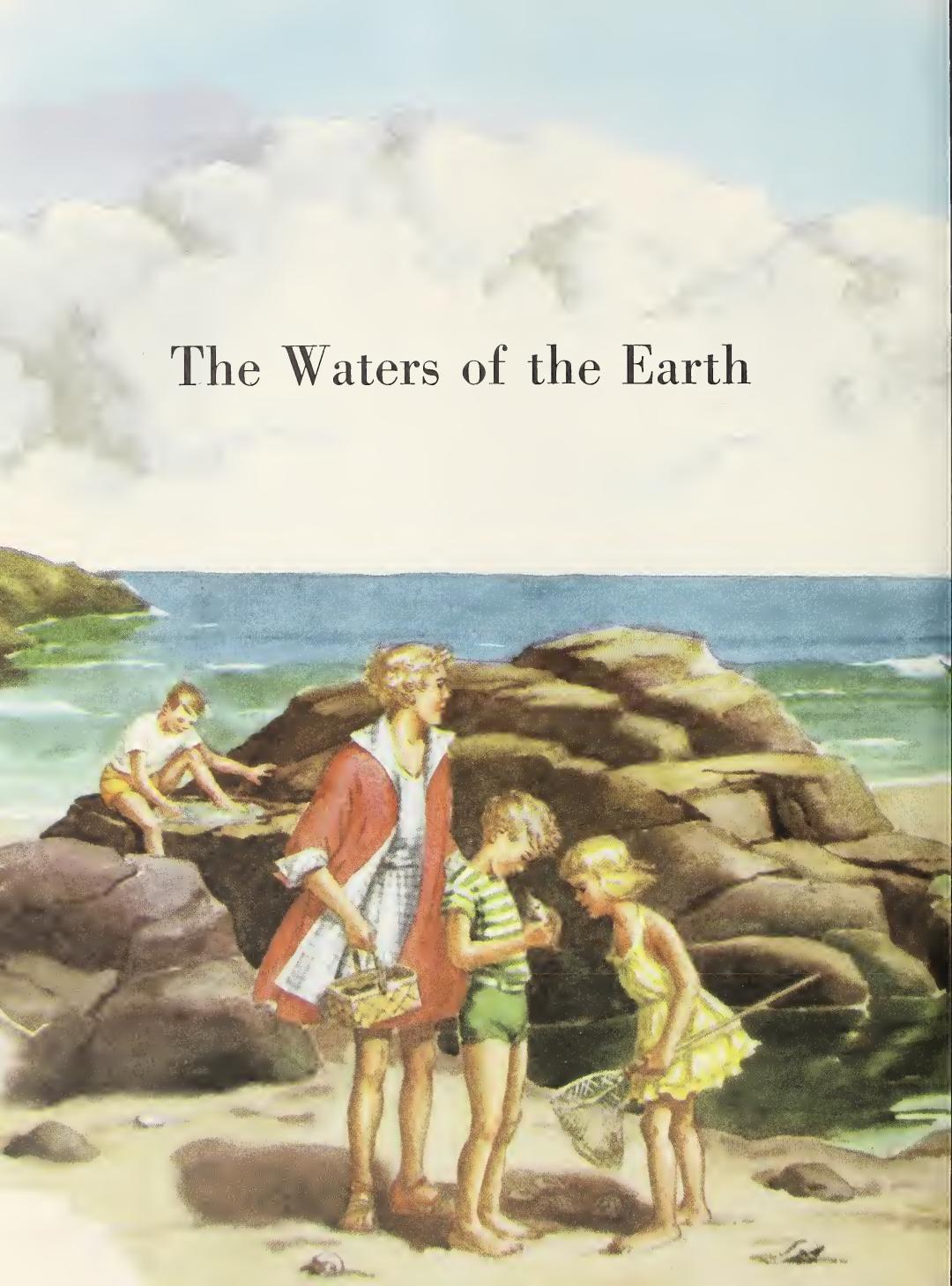
10. Can you tell whether the bell is ringing?



11. Can you tell why the light is not on?



The Waters of the Earth



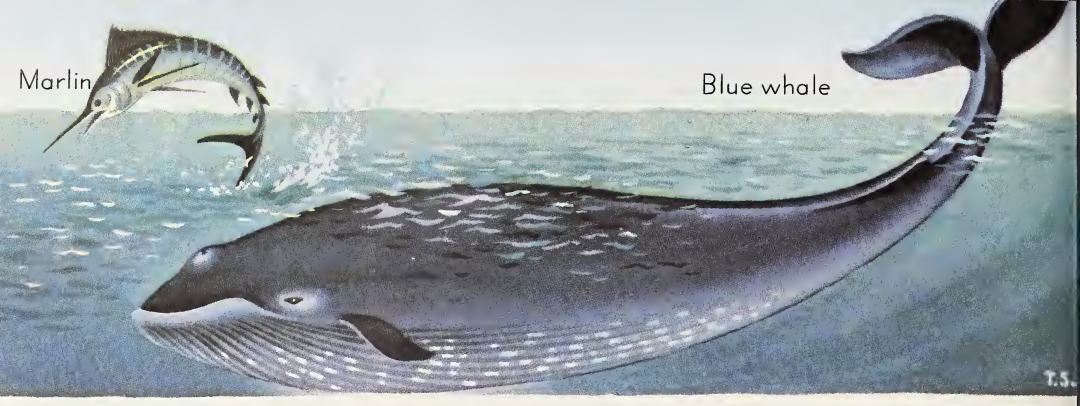
Oceans, Lakes, and Streams

As you look about you, you might think that most of the earth is dry land. You may be surprised to discover how much of the earth's surface is water.

Look carefully at a globe or a map of the world and find the four great oceans. These oceans make up most of the water part of the earth. Do you see how they are connected? Together they form one mighty ocean, which surrounds all the lands of the earth.

Do you see lakes and rivers on your globe or map? Small as they seem, they cover many, many square miles of the earth's surface.

Perhaps now you do not find it hard to believe that only about one fourth of the surface of the earth is dry land. All the rest is water, and most of this water is the mighty ocean.



Life in the Ocean

Have you ever stopped to think about the many, many plants and animals that live in the oceans of our earth? Some of these float about in the water. Some animals crawl, some swim, and others fasten themselves to rocks, piers, or boats.

Some build up great reefs of rock, called coral, upon the ocean floor. In time these reefs of coral may rise out of the ocean and become islands.

Some of these plants and animals are among the largest things now living. The blue whale is the largest animal on our earth today. Iodine kelp, a seaweed found in the Pacific, sometimes grows several hundreds of feet long. It is one of our largest living plants.

Yet some of the plants and animals that live in the ocean are among the smallest living things on earth. They are so tiny that you can see them only through a microscope. They are so tiny that thousands and thousands of them might be found in one cup of ocean water.

As you ride through the waves of the blue-green waters of the ocean in your speedboat, the animals below you may swim, walk, or crawl to safety. Some hide in the mud, under rocks and shells. Others hide in the seaweed. Still others dig down deep into the sand and hide there. There they are safer from their many enemies. Let's find out about the strange and beautiful life in the ocean.

We shall call the top two hundred feet or so of the ocean its surface. It is in these surface waters that many, many tiny plants and animals live.

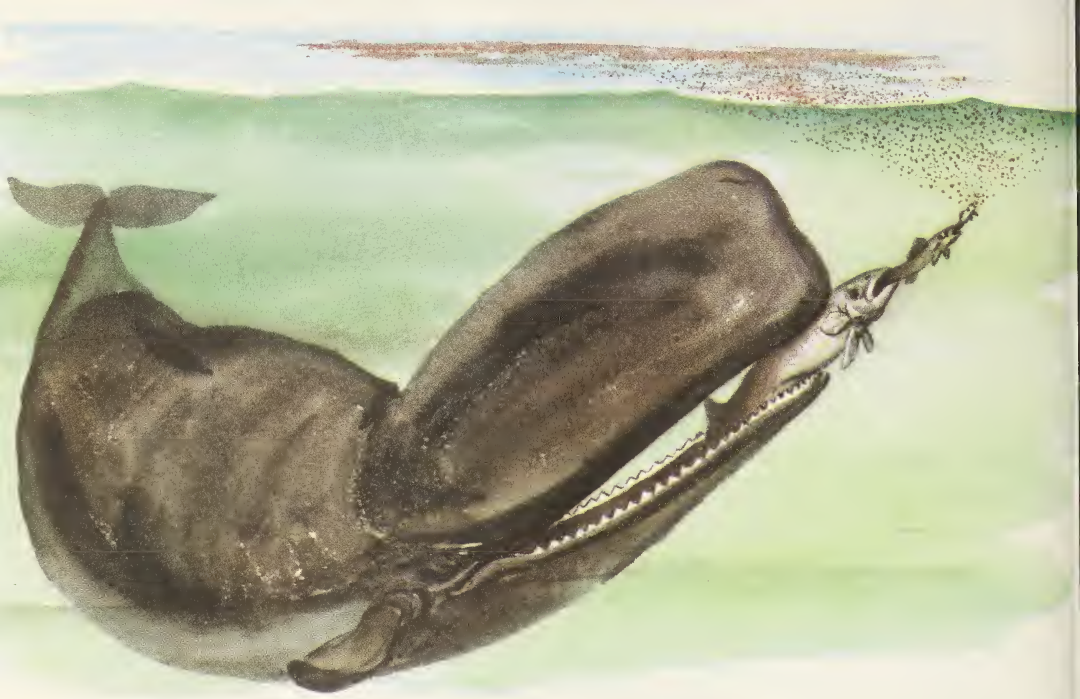
Someone has said that these waters are the vegetable gardens of the ocean. That is very nearly the truth. For billions of tiny plants live here. To make their food, they need the sunshine that comes through the water. The plants float about unseen near the surface of the ocean.

Sometimes this top part of the ocean is called by another name. People often speak of it as the nursery of the ocean.

And so it is. For it is here that many, many sea creatures lay their eggs. It is here, too, that the young of many sea animals live. They are the animal part of the tiny, tiny life of the ocean.

What better place could there be for a nursery for the young! Just by opening their tiny mouths, they may be able to get a whole meal of green vegetables.

These billions and billions of tiny, living plants and animals are called plankton. Plankton is a very important part of the life of the ocean. It furnishes food for almost all the larger animals that live in the ocean.



If something were to happen to this living mass of plant and animal life, there would be a real food shortage in the ocean. For even the whales feed upon the plankton of the ocean.

Here is the way it works: some whales eat huge fish, which eat large fish, which eat medium-sized fish, which eat small fish, which eat smaller fish, which eat tiny fish, which eat plankton. My, what a tale!

You may be surprised to learn that there is plankton in the surface water of all the oceans. There is more of it in cool and cold ocean water than there is in warm ocean water. Even the cold Arctic Ocean has a great deal of plankton in it. Sometimes the plankton is so thick that people say the water is soupy.

The narrow strip of water between Alaska and Russia is one of these places. This is called Bering Strait.

Sometimes we hear a farmer talk about how many bushels of corn or potatoes he raised on an acre of land. But did you ever think that an acre of ocean water could also give a good crop?

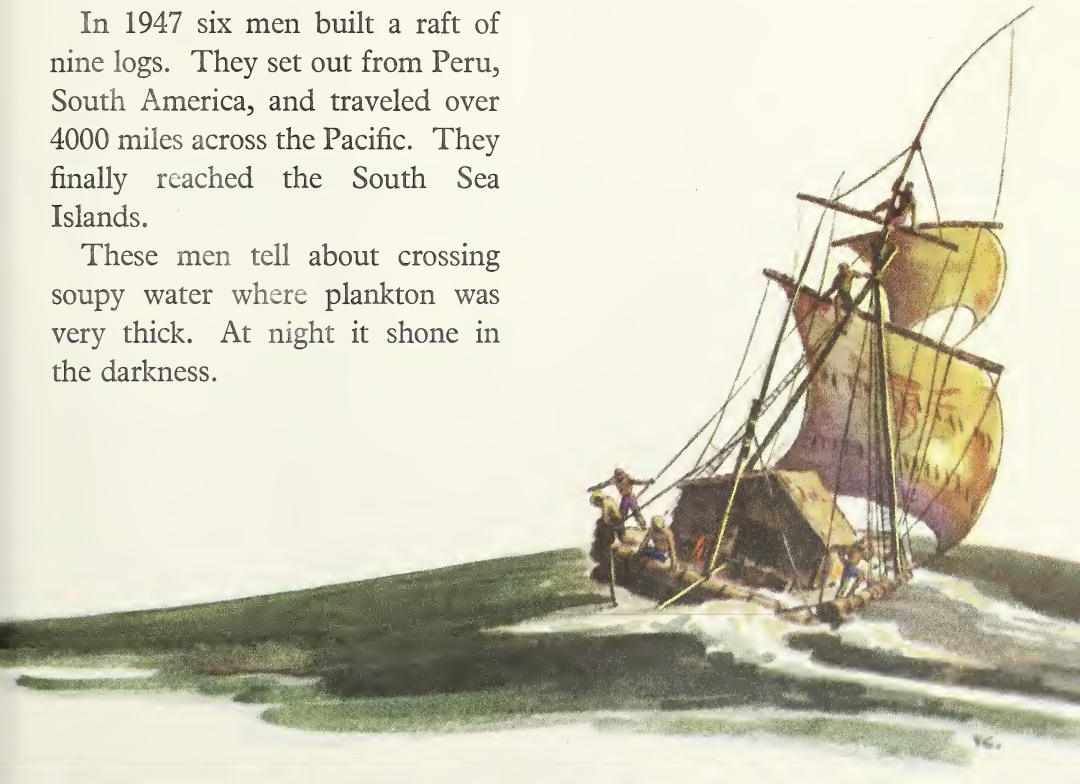
One scientist tells us that if an acre of surface ocean water were strained of its tiny sea plants and sea animals, this crop would be as important as the crop from an acre of land.

In 1947 six men built a raft of nine logs. They set out from Peru, South America, and traveled over 4000 miles across the Pacific. They finally reached the South Sea Islands.

These men tell about crossing soupy water where plankton was very thick. At night it shone in the darkness.

As plankton floats about in the surface water of the ocean, much of it is eaten by the animals there. But some of the tiny creatures in the plankton die and sink toward the bottom of the ocean. As they sink, they may be eaten by deep-sea animals.

The plankton that settles on the bottom of the ocean becomes part of the great ooze that covers the ocean floor. The tiny bones and shells of animal plankton are part of the material out of which some limestone is formed.



Between the Tides

How interesting the seashore is! Twice each twenty-four hours the water of the ocean reaches far up on the land. We say that it is high tide then.

Twice each twenty-four hours the ocean water withdraws along the shore. We say the tide is going out. Just before the water turns and begins to come in again, we say it is low tide.

At high tide much of the shore is covered with salt water. At low tide the region from which the water has withdrawn becomes part of the land.

This region between the tides is a place of great change. The plants and animals that live there have to be able to live through both wet and dry times.

You might think that there are only a few living things on the seashore. But this is not true. Many plants and animals make the shore their homes.

The animals are awake and busy as the salt water brings food in to them at high tide. The rest of the time they are protected from the dry air in ways which, as we shall see, keep them from drying out.

Along Rocky Shores

You may have seen barnacles fastened tightly to rocks along the shore. These little animals fasten themselves to rocks or boards or docks. In this way they keep from being washed out to sea.

A barnacle shell looks like a tiny volcano. It has steep sides with a door on top. The barnacle closes its door as the tide goes out.

At high tide the barnacle opens its door and waves feathery feelers about in the water. These feelers catch whatever food floats past.

As the tide goes out again, the barnacle closes the door and keeps it shut until the next high tide.

Sometimes you may also find another kind of animal fastened right beside barnacles. These animals are mussels. They are fastened to rocks or wood by hundreds of tiny threads.

At high tide mussels open their shells and feed upon the tiny plants and animals that go by. After a fine feast they close their shells and wait for low tide and drying-out time.

The next time you go to the shore, look for places where barnacles and mussels might live. See if you can find out more about these little animals.

Blue crab

Hermit crab

Sea anemones

Perhaps you have seen crabs hurrying to good hiding places as the tide goes out. There are many kinds of crabs along the shore. It is fun to watch them move sideways looking for food, which they catch in their two claws. They aren't very fussy about what they eat. Almost any plant or animal, dead or alive, will do.

As a crab grows, its shell gets too small. So it walks out of it. Now it must hide and wait for its new, soft shell to grow hard.

A hermit crab has a different trick. It crawls into an empty shell that once belonged to another sea animal. When it is little, it may use the empty shell of a small snail.

When the hermit crab grows larger, it chooses a larger shell for a home. You will often see these crabs crawling over rocks, eating plants that grow there.

Perhaps you have seen beautiful objects in the water that look for all the world like flowers. They may be white or orange or yellow or purple. These objects are often found on rocky shores.

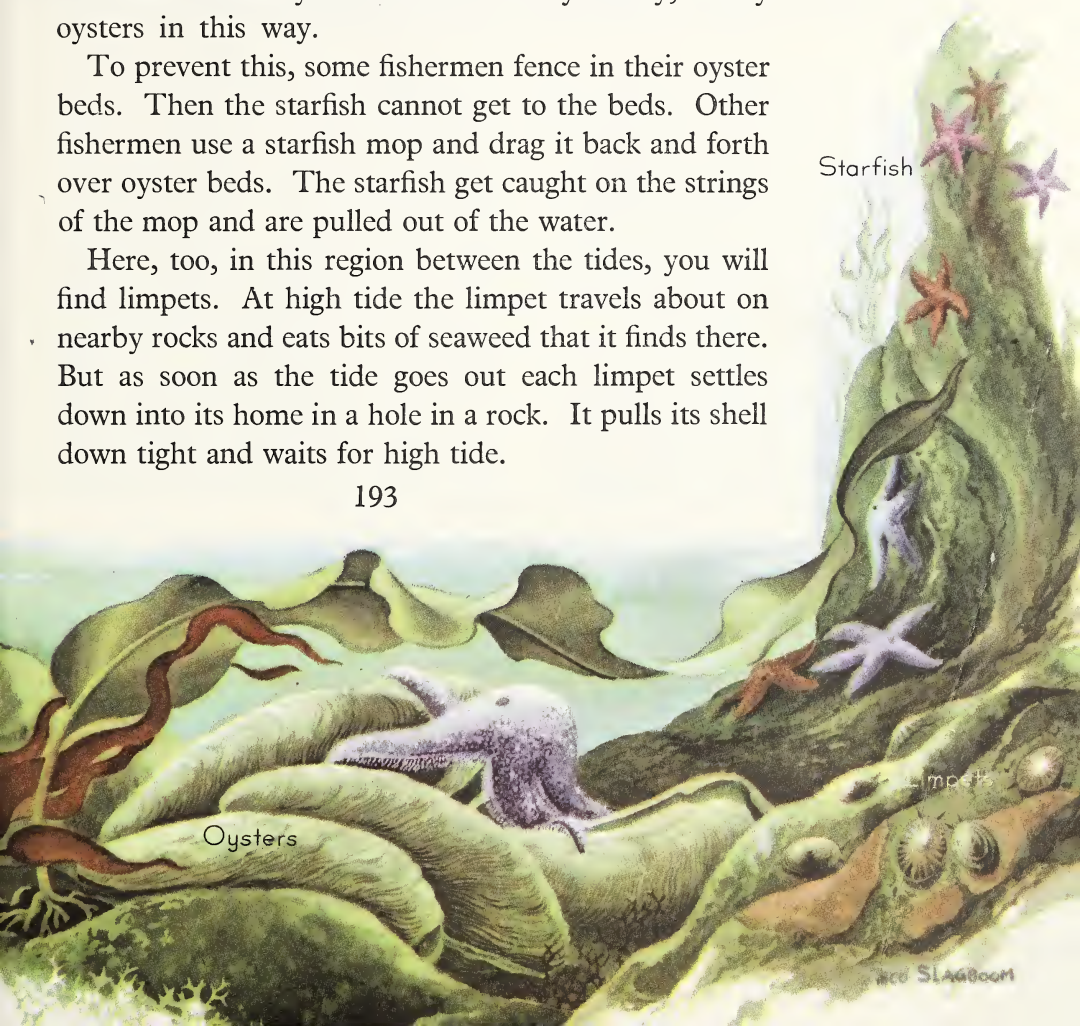
But watch out! These are not harmless flowers. They are animals. These little animals, called sea anemones, wave their flowerlike feelers back and forth and catch food with them. The feelers sting whatever floats, crawls, or swims within easy reach.

Oysters also live in this region between the tides. They fasten themselves to rocks along the shore and open their shells at high tide. They feed upon plants and animals that float past.

You will also find starfish along the rocky shore. They move about over the rocks, fastening themselves by their feet when the need arises. Starfish eat mussels, oysters, and many small fish. They pull open the shells of mussels and oysters by fastening their feet to them. Each year starfish destroy many, many oysters in this way.

To prevent this, some fishermen fence in their oyster beds. Then the starfish cannot get to the beds. Other fishermen use a starfish mop and drag it back and forth over oyster beds. The starfish get caught on the strings of the mop and are pulled out of the water.

Here, too, in this region between the tides, you will find limpets. At high tide the limpet travels about on nearby rocks and eats bits of seaweed that it finds there. But as soon as the tide goes out each limpet settles down into its home in a hole in a rock. It pulls its shell down tight and waits for high tide.



Along Sandy Shores

So far we have been reading about creatures that live on rocky shores. But what about sandy beaches? Are they the same?

No, these shores differ a good deal. It is here that you may sometimes dig holes and play in the cool, wet sand. It is here you may run out and splash about in the waves.

Have you ever seen a row of dead-looking, brown seaweed near the high-water mark all along a sandy beach? On this seaweed live small beach fleas and other insects, which may bother you as you eat your picnic lunch nearby.

Not far away you may see a great many little humps of wet sand. Under these many humps are small snails, ready to drill holes into clams if they find any.

What on earth is that big-headed, short-tailed creature crawling at the edge of the water? That's a horseshoe crab looking for a meal of worms or perhaps for a place to lay its eggs.

If you look closely at the wet sand, you will almost surely see bubbles coming out of it. At low tide most of the animals along a sandy beach are buried in the sand.

But although you cannot see the animals under the sand, some of them can see you. Some creatures have eyes at the ends of short stalks. At a moment's notice they dig holes in the sand and bury themselves. No one can see them.

But how clever! Those eyes on the ends of stalks stay right at the top of the sand. They can see all that is going on.

Low tide on a sandy beach

Low tide on a muddy beach

Along Muddy Shores

Perhaps you have seen seashores on which you would not like to play. There are many such shores. Black, muddy places they are. If you step on them, your feet sink into the soft mud. These places are sometimes called mud flats.

Mud flats are the homes of soft-shelled clams, which your mother may use for clam chowder. Sometimes these clams are called long-necks because of a long tube, or neck, out of which water comes as you walk near. This water comes up from the clam, which is buried a foot or more deep in the mud. You would have to dig deep to catch the clam.

Here also you will find many kinds of crabs. Along the muddy flats blue crabs walk out of their small, hard shells and wait for their soft, new shells to grow hard.

Spider crabs covered with seaweed dart around on the muddy flats. They can bury themselves quickly when you come near. Buried safely in the mud, they watch you as you walk along.

Many sea worms live here, too. They bury themselves in the mud flats at low tide. At high tide they come out of their holes in the muddy flats and eat. But as soon as the tide goes out, they bury themselves again.

Sea bass

Mackerel

Flounder

Beyond the Reach of the Tides

In the shallow waters offshore there is still another world of life. Here, along with some of the animals you have just been reading about, many free-swimming creatures live.

Fish by the hundreds swim about in the shallow water. Here they find food and lay eggs.

Some of them feed near the top of the water, eating plankton. Others swim near the bottom, feeding upon the many creatures that live there.

It is in these offshore waters that fishermen, sitting in boats, wait for fat fish to bite the bait on their fishhooks. It is here that men may set lobster pots to trap big lobsters, whose meat some people call "the best of all sea food."

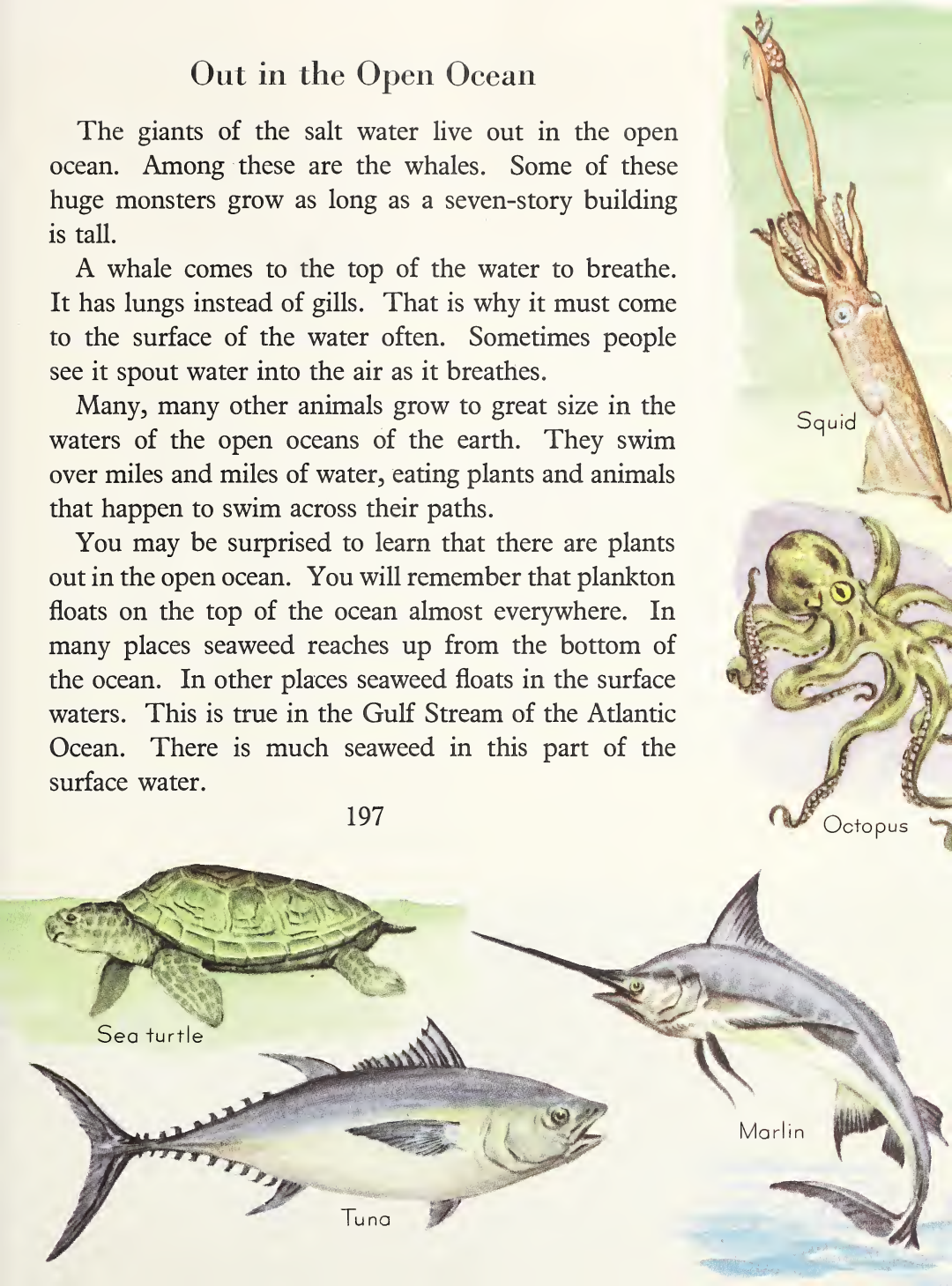
Out in the Open Ocean

The giants of the salt water live out in the open ocean. Among these are the whales. Some of these huge monsters grow as long as a seven-story building is tall.

A whale comes to the top of the water to breathe. It has lungs instead of gills. That is why it must come to the surface of the water often. Sometimes people see it spout water into the air as it breathes.

Many, many other animals grow to great size in the waters of the open oceans of the earth. They swim over miles and miles of water, eating plants and animals that happen to swim across their paths.

You may be surprised to learn that there are plants out in the open ocean. You will remember that plankton floats on the top of the ocean almost everywhere. In many places seaweed reaches up from the bottom of the ocean. In other places seaweed floats in the surface waters. This is true in the Gulf Stream of the Atlantic Ocean. There is much seaweed in this part of the surface water.



On the Dark Ocean Floor

As you travel across the top of the open ocean in a big ship, you may not stop to think of how the land looks far below you. But suppose that you could ride along the bottom of the ocean in a jeep.

Your jeep would have to go down steep, steep slopes into deep, dark valleys. These valleys are so deep that the highest mountains of the earth would sink out of sight if they could be placed down in them. We believe the deepest valleys to be about 7 miles deep.

Some of the time your jeep would travel across level plains. Some of the time it would have to go into low speed in order to reach the tops of great, tall mountains.

The highest mountains in the ocean stick up above it. We call them islands. Can you find some mountain islands on your world map? The Hawaiian Islands are really tops of mountains that stand in water. Cuba and Puerto Rico are also the tops of some great mountains that rise out of the waters of the oceans.

Yes, the land under the ocean has valleys, hills, mountains, and many flat plains, just as the land around the ocean has.

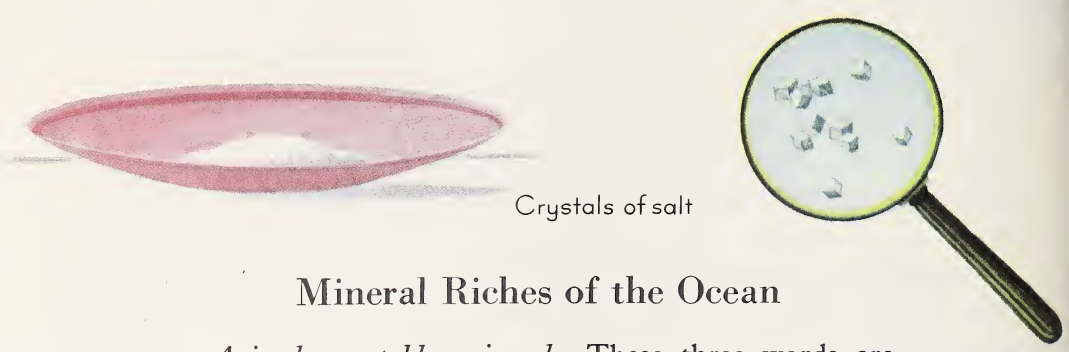
Imagine what it would be like to ride in a jeep through a deep ocean valley. Think of a place about 7 miles from the place where you are standing right now. Then imagine that you are riding in your jeep with as many miles of water as that above you.

Your jeep would have to have its headlights on as it traveled on the deep ocean floor. For even in the daytime it would be as dark as midnight. Sunlight shines through only the top 600 to 1000 feet or so of the water of the ocean.

There are no plants living on the floor of the deep, dark ocean. The plants of the ocean live in the top few hundred feet of water. Because plants need light in order to grow, they cannot live below this depth. Yet these dark valleys do have some living things in them. They are the homes of many strange-looking fish.

Some of these fish carry dimly glowing lights on their bodies. These lights are sometimes on feelers that rise above the heads of the fish. Sometimes they are in rows along the sides of their bodies. Aside from these dim lights there is not one speck of light at the bottom of the deepest parts of the ocean.

All these deep-sea animals have large, powerful jaws and teeth. They need them because they all eat only animal food. This is truly a place where animals eat each other up.



Crystals of salt

Mineral Riches of the Ocean

Animal, vegetable, mineral. These three words are used when you play the game called Twenty Questions. It is now no secret to you that the waters of the ocean are full of plants and animals. But you may never have thought of the minerals that are there, too.

Many metals and minerals are found in ocean water. You may wonder how they came to be in the ocean. The swift waters of small streams and large rivers dissolved them as it passed over the places where the rocks and minerals were.

To be sure, they were not dissolved quite as a lump of sugar or a teaspoonful of salt dissolves. It takes a long, long time to dissolve even a little bit of metal or mineral. Little by little, year after year, running water has dissolved minerals and metals over which it flowed.

These bits of minerals and metals are so tiny that we cannot see them as we look at water. Your mother sometimes knows they are there. Ask her to show you the inside of her teakettle. Is there a coating of something on the bottom?

This coating may be a mineral called lime. If you shake the empty kettle, pieces of the coating will break loose. The mineral was dissolved in all the water that your mother had put into the kettle. As the water boiled, the mineral was left.

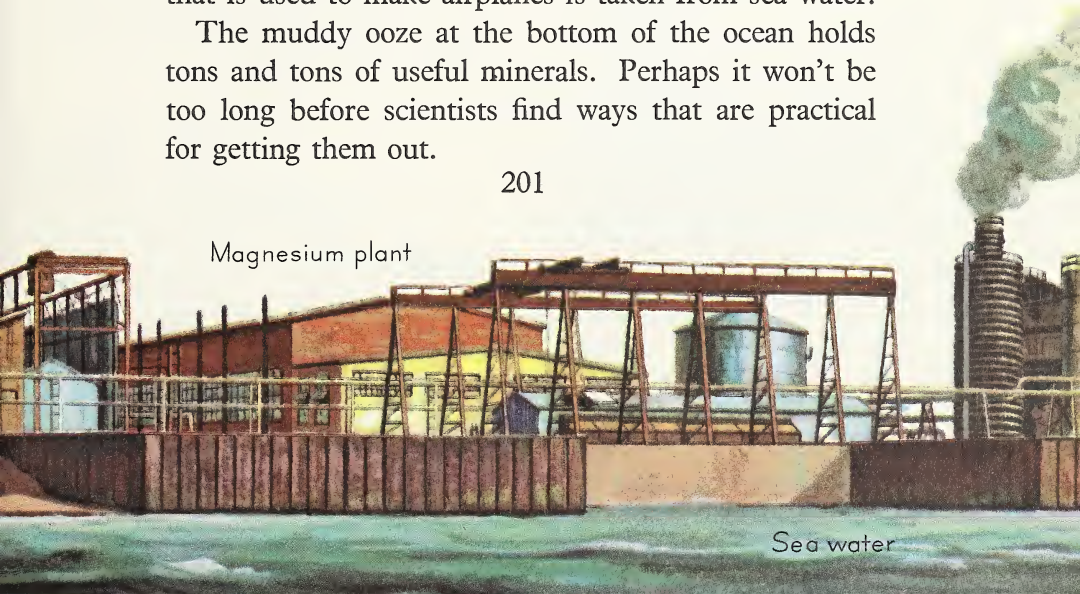
Salt is one of the minerals found in ocean water. You can get it out by evaporating some of the water in shallow pans. Small bits of salt are left in the pans after the water has evaporated. If you live near the ocean, try this and see.

There are factories where salt is removed from salt water. On the shores of Great Salt Lake in Utah you can see such factories. Here salt water is being changed to fresh water.

Scientists are at work trying to find better ways of removing salt from water. This work is very important because not only is the salt useful to us, but the fresh water may be of great value. When better ways are found of changing salt water to fresh, the water of oceans and salty seas can then be used for irrigation. Lands that are now too dry to be farmed may be made to grow crops.

Have you ever heard your dad talk about magnesium? It is one of the metals that is used in making airplanes. It is strong and light in weight. Much of the magnesium that is used to make airplanes is taken from sea water.

The muddy ooze at the bottom of the ocean holds tons and tons of useful minerals. Perhaps it won't be too long before scientists find ways that are practical for getting them out.



Life in Ponds and Lakes

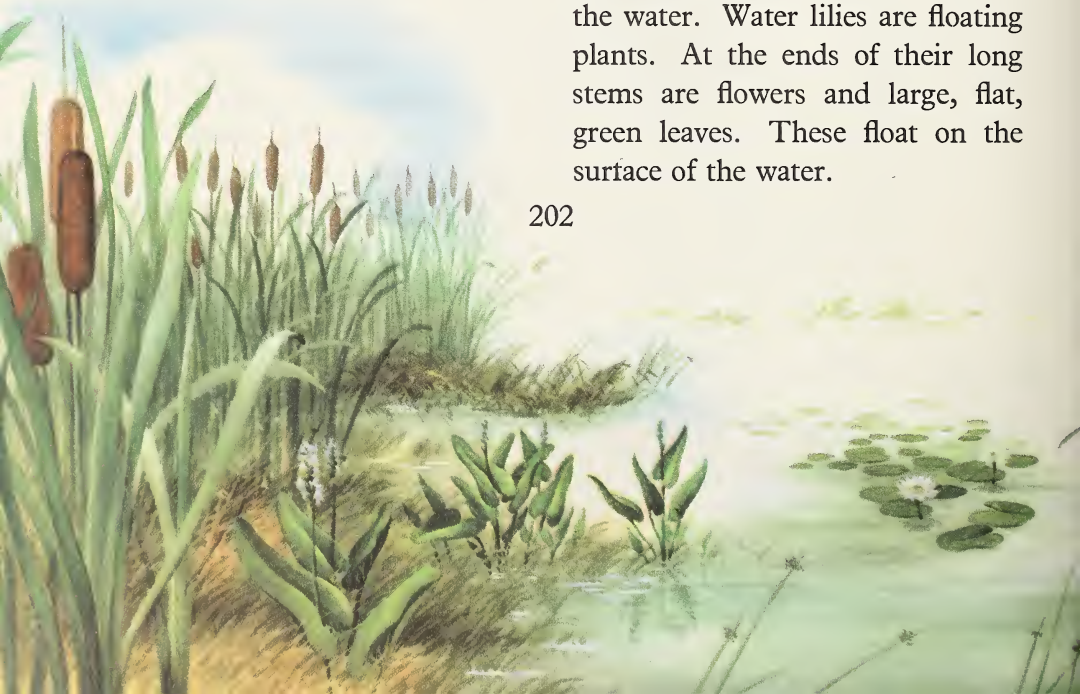
Now we are going to take a look at the world of life in fresh-water ponds and lakes. This world of life is quite different from the salt-water life that you have just been reading about.

Around the outer rim of many ponds and lakes you may see cattails growing. Some of them grow right out in the shallow water. Their roots reach down into the muddy bottom. Their tall, brown spikes stretch up into the sunshine above the water. They look for all the world like an army standing, ready to march off.

Here, too, are some of the other plants you see in the picture below: reeds and bulrushes and marsh grass. Some of these plants have lovely purple, white, or yellow flowers on them.

All these water plants might be called waders because they seem to wade in the water. Parts of each plant stand high above the surface of the water.

A little farther out from shore are the plants that might be called floaters. Their roots are in the mud at the bottom of the pond. Their leaves and flowers float on the water. Water lilies are floating plants. At the ends of their long stems are flowers and large, flat, green leaves. These float on the surface of the water.



Other floating plants are found in the fresh water of ponds and lakes. The roots of these plants too are in the mud at the bottom of the pond. Their broad leaves and lovely flowers float on top of the water.

A little farther out from shore are the plants that grow under the water. You may have seen some of these plants if you have gone out in a rowboat. Their tall stems and leaves move back and forth just under the surface of the water. Fish lie near such plants, for these are good hiding places for them.

Sometimes there is a green scum on top of the water. This is like the scum that may form in your school aquarium at times. It is really fresh-water plankton. Many water animals feed upon it.

Perhaps you have noticed many dragonflies flying around you as you have stood near the shores of a pond or lake. These shores are their homes. In their younger days the dragonflies are called nymphs. The nymphs do not look much like the grown-up dragonflies.

Dragonfly nymphs live in waters of ponds or lakes. They have mouths which open quickly to scoop up whatever food they find in the water. When they become grown-up dragonflies, they live along the shores nearby.

Some of the other insects you will find in the pond have long legs and stride, or walk, over the top of the water without falling in. That is a stunt you cannot do! But water-striders can do just that.

One water creature hangs bottom side up on the top of the water. Have you ever seen this funny sight? Look for these upside-down insects next time you go to a pond. They are called back swimmers.

"Croak, croak, croak!" Yes, that's a big bullfrog over among the lily pads, calling to its mate.

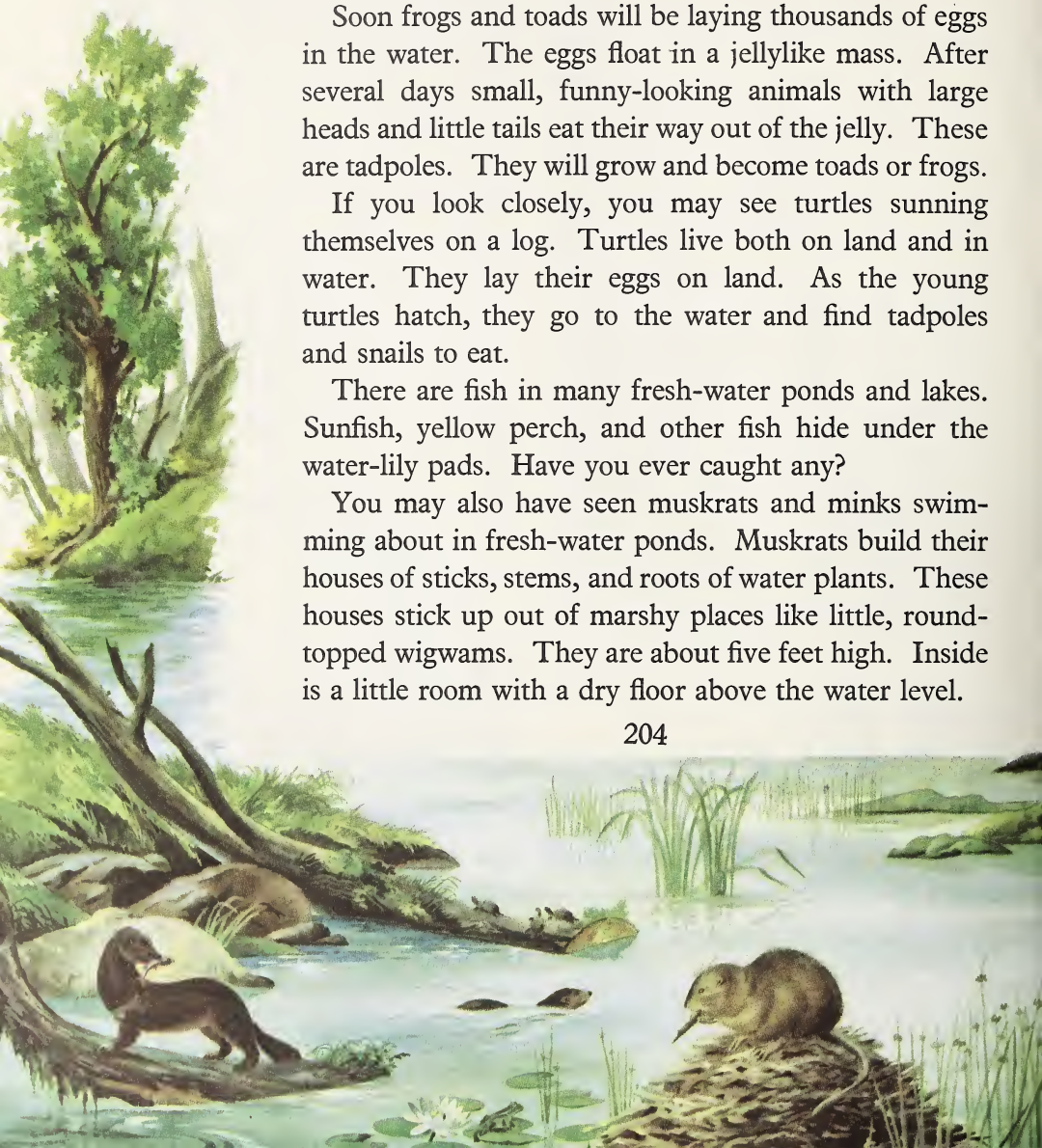
"Peep, peep, peep!" Yes, that's the shy little peeper, or tree toad, calling to its mate. My, what a chorus! It's spring at the pond.

Soon frogs and toads will be laying thousands of eggs in the water. The eggs float in a jellylike mass. After several days small, funny-looking animals with large heads and little tails eat their way out of the jelly. These are tadpoles. They will grow and become toads or frogs.

If you look closely, you may see turtles sunning themselves on a log. Turtles live both on land and in water. They lay their eggs on land. As the young turtles hatch, they go to the water and find tadpoles and snails to eat.

There are fish in many fresh-water ponds and lakes. Sunfish, yellow perch, and other fish hide under the water-lily pads. Have you ever caught any?

You may also have seen muskrats and minks swimming about in fresh-water ponds. Muskrats build their houses of sticks, stems, and roots of water plants. These houses stick up out of marshy places like little, round-topped wigwams. They are about five feet high. Inside is a little room with a dry floor above the water level.

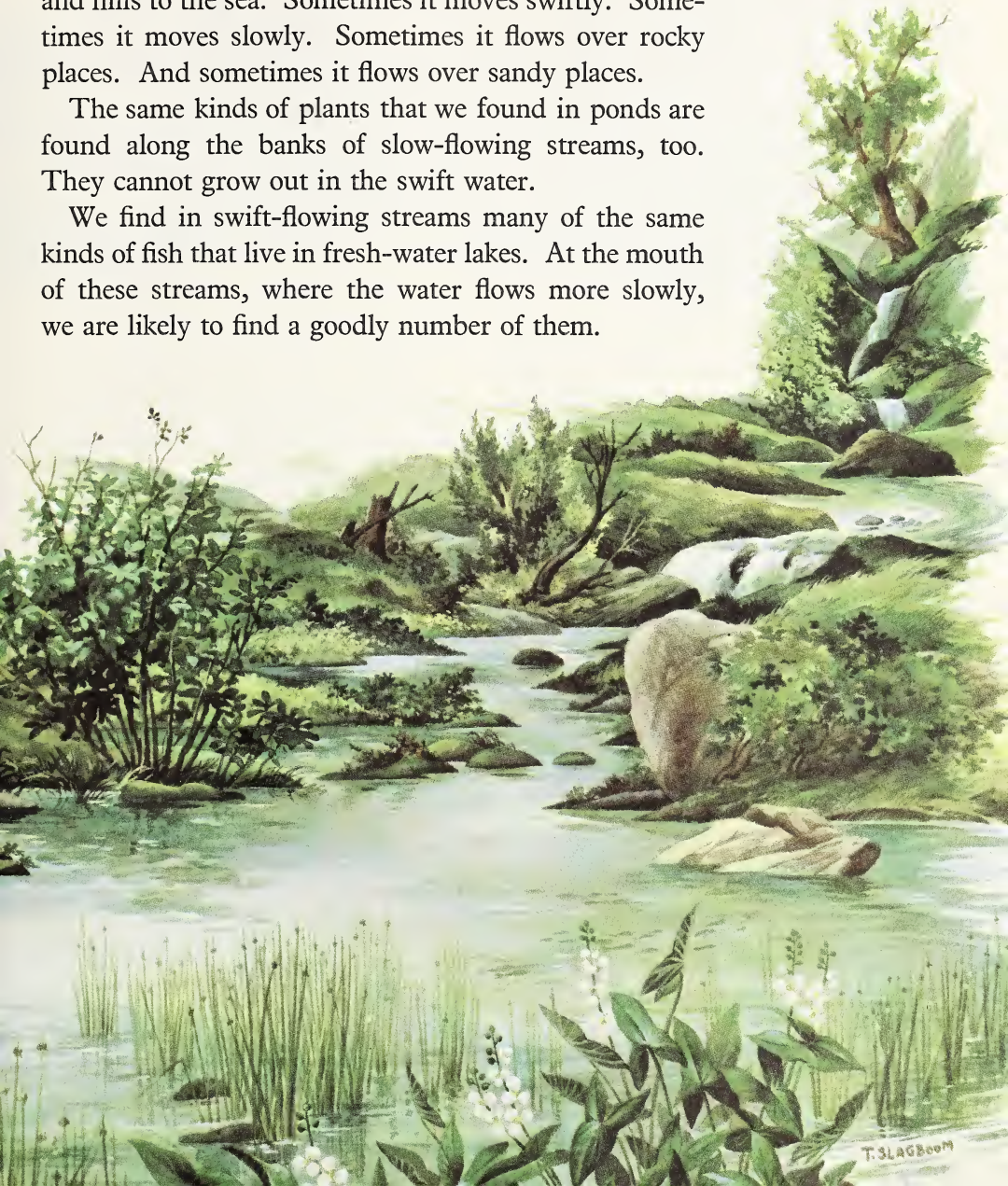


Life in Streams

The water in streams flows along from mountains and hills to the sea. Sometimes it moves swiftly. Sometimes it moves slowly. Sometimes it flows over rocky places. And sometimes it flows over sandy places.

The same kinds of plants that we found in ponds are found along the banks of slow-flowing streams, too. They cannot grow out in the swift water.

We find in swift-flowing streams many of the same kinds of fish that live in fresh-water lakes. At the mouth of these streams, where the water flows more slowly, we are likely to find a goodly number of them.



Stocking Streams with Fish

Many people like to fish. It is really a very pleasant way to have fun. Your whole family can pack a lunch and go off together for a day in the open air and sunshine.

Places to catch fish are not as easy to reach as they once were. You may have to go farther and farther away from home in order to find a good fishing place.

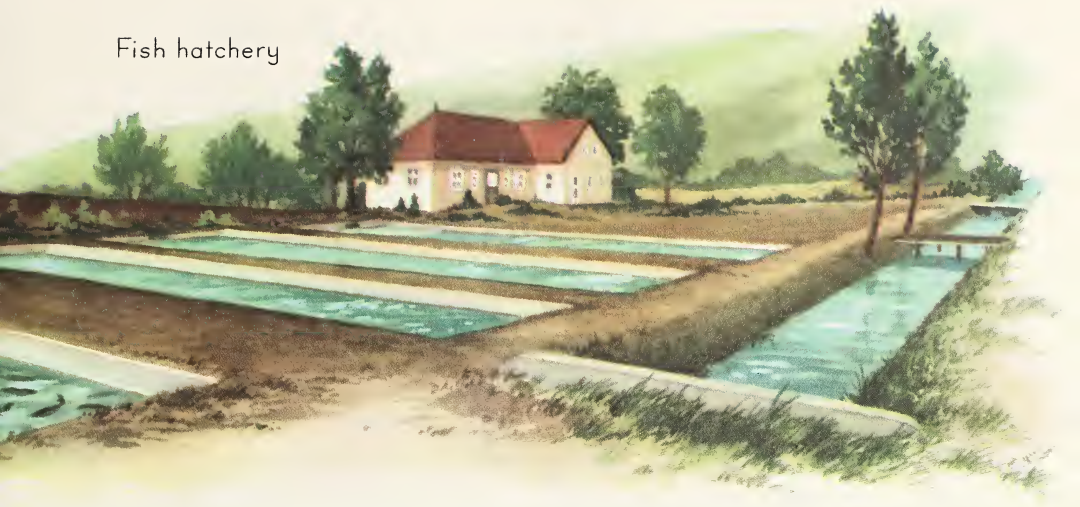
The streams nearby may be almost fished out. That is to say, there may not be many fish left in those streams. Is this the case where you live?

Do you ever hear older people say, "Fishing is no good around here any more"?

Many things may have happened. Perhaps the water in these streams has become polluted. But other things may have happened, too.

Some people are careless when they fish. They catch more fish than they can eat. Yet they keep right on fishing and fishing.

Others are careless about the size of the fish they keep. Instead of carefully putting small fish back, they keep all they catch.



Fish hatchery

It doesn't take long for careless fishermen to spoil a stream for fishing. Pretty soon fishermen say, "There are no fish in this stream."

Have you ever heard of fishing laws? They are made to keep careless fishermen from spoiling a stream for fishing.

Each state and province has its own fishing laws. These laws tell you when you may fish for certain kinds of fish. They tell you how large your fish must be. They also tell you the number of fish you may catch in any one day.

These laws are made to help to keep fishing good for everyone who likes this sport.

Here is another way that fishing is being improved: Fish hatcheries are stocking streams with young fish. Stocking streams with fish means putting small fish into the waters where they may grow bigger.

These hatcheries raise thousands and thousands of young fish. When the fish are large enough, they are carried to lakes and streams and carefully let go.

Some of the streams that were spoiled for fishing are now becoming good fishing streams again. They are being stocked with young fish from hatcheries. Hatcheries keep raising fish and putting them into streams each year.

Rivers Are Roadways

The large rivers often seem to be roadways that many deep-sea fish use when migrating. At certain times of the year eels are found in many, many rivers.

Eels live in fresh-water ponds and lakes for six or seven years. Then they swim down the rivers and out to sea.

Salmon also use many rivers as roadways. Millions of shiny salmon live and grow up in the ocean. When they are full grown, they begin the long and dangerous trip upstream.

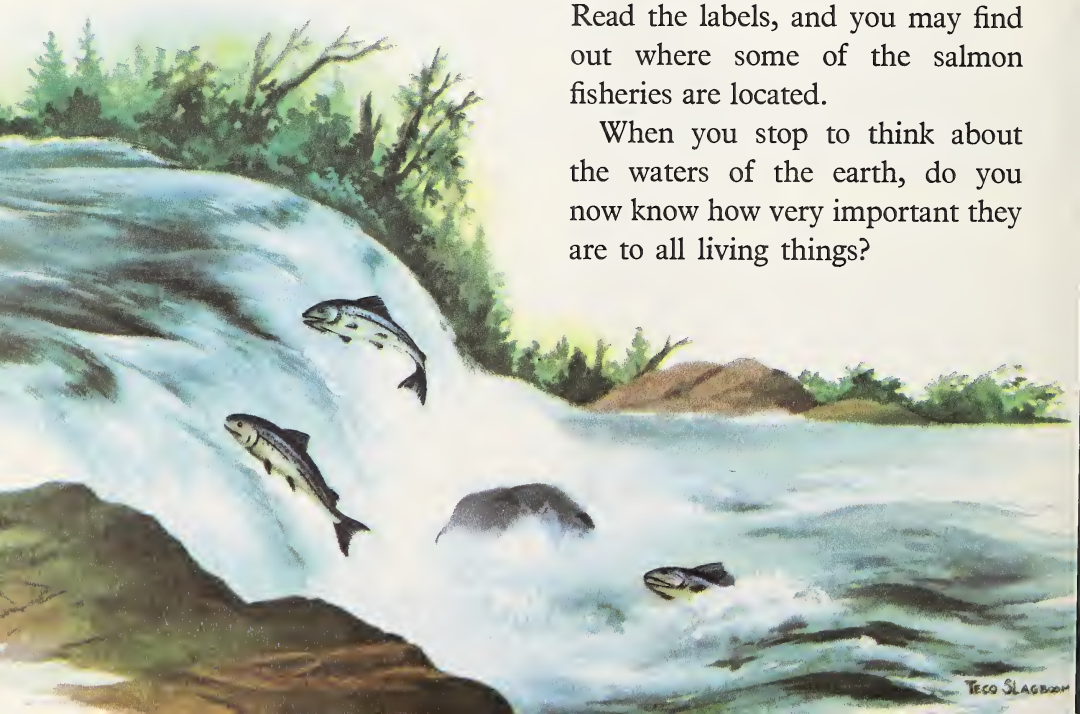
Salmon swim against swift currents, leaping dangerous rapids and waterfalls. Many of them die on the way upstream.

Salmon fisheries are built at the mouths of many big rivers. As the salmon migrate upstream, millions and millions of them are caught and canned for us to eat.

These salmon fisheries are the most important of all river fisheries. Each year the value of this industry alone runs into millions of dollars.

The next time you go to the store for your mother, look for the shelf where cans of salmon are kept. Read the labels, and you may find out where some of the salmon fisheries are located.

When you stop to think about the waters of the earth, do you now know how very important they are to all living things?



SOME THINGS TO THINK ABOUT AND DO

1. Is there a place nearby that you can visit to see the plants and animals that live in water? You may see many more of them than you have read about here. The waters of the earth are the homes of so many interesting and different kinds of living things. Talk about some of the ones you have seen.

2. You will want to help keep the water in ponds and streams and lakes free from anything that would kill the plants and animals that live in them. What can you and your classmates do to help?

3. Try to find out if anything is being done in your community to help people take pride in keeping streams or lakes or the ocean free from pollution. Are there any sewage-disposal plants being planned or built? What else can be done to make your community a better and safer place in which to live? What can you do to help?

4. What interesting shapes these shells have! Some shells have two parts. Others have only one part. What beautiful colors they are, too! No two of them are alike in size or shape or color. Each of these shells once had a living sea animal inside it.

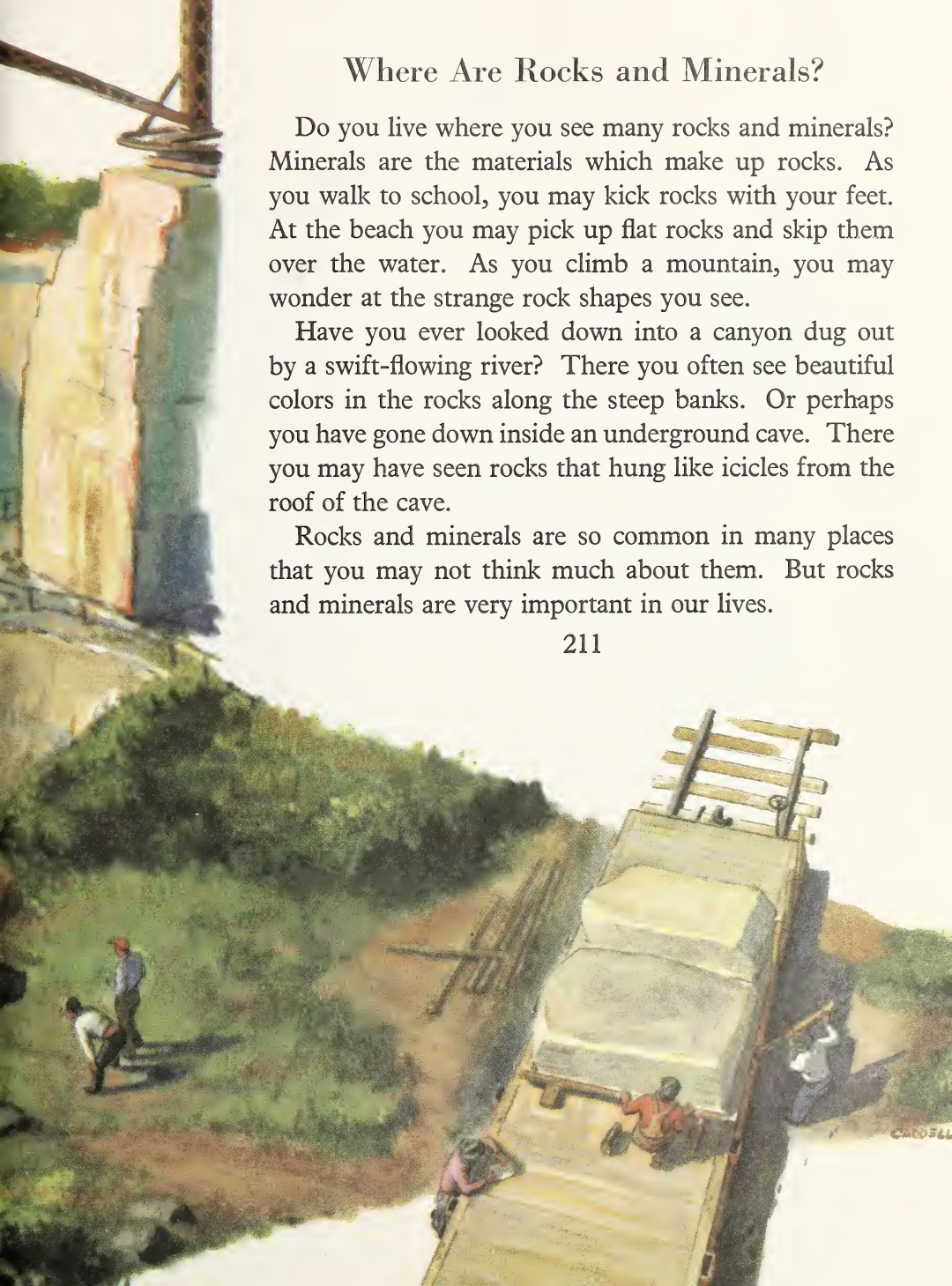
Studying Rocks and Minerals

Where Are Rocks and Minerals?

Do you live where you see many rocks and minerals? Minerals are the materials which make up rocks. As you walk to school, you may kick rocks with your feet. At the beach you may pick up flat rocks and skip them over the water. As you climb a mountain, you may wonder at the strange rock shapes you see.

Have you ever looked down into a canyon dug out by a swift-flowing river? There you often see beautiful colors in the rocks along the steep banks. Or perhaps you have gone down inside an underground cave. There you may have seen rocks that hung like icicles from the roof of the cave.

Rocks and minerals are so common in many places that you may not think much about them. But rocks and minerals are very important in our lives.



Learning about Minerals

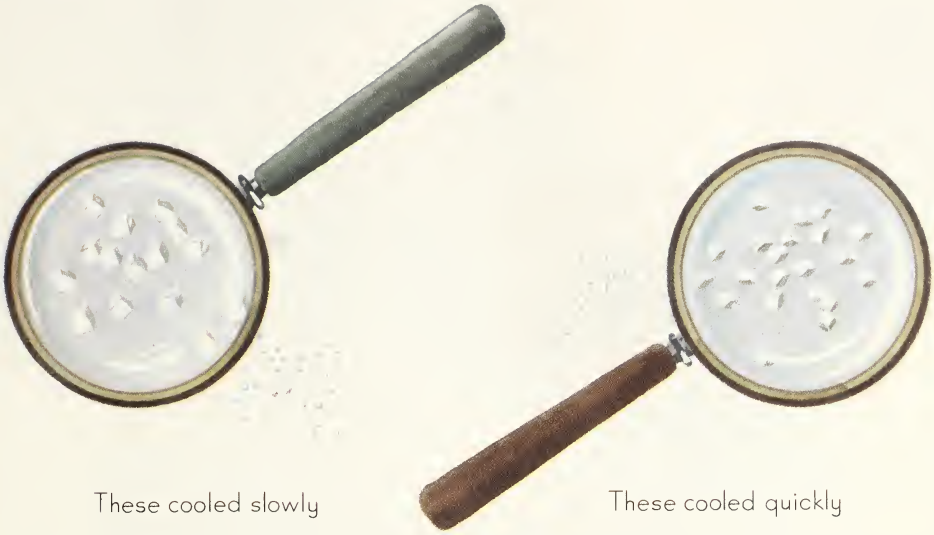
There are many kinds of minerals. Some are very common, and others are quite rare. Minerals are formed inside the earth. They are formed as hot materials inside the earth cool.

You might compare these hot materials with the cooky batter which your mother makes in your kitchen. If she wants to make white, sugar cookies, she uses certain materials. If she wants to make brown, chocolate cookies, she uses other materials.

The hot materials inside the earth differ in different places. Some materials form one kind of mineral. Other materials form another kind. That is why there are many kinds of minerals on our earth.

You can make some mineral crystals this way: Fill a cup about half full of boiling water. Add several spoonfuls of rock salt to it. The salt will dissolve in the water. After it cools a little, pour it into a glass. Now hang a piece of string above the glass so that the end of the string falls into the water.

Do not move the string for about three weeks. At the end of that time you will find that crystals of salt have formed on it. You have made mineral crystals. Salt crystals, like the ones you have just made, form inside the earth in many places. Your mother uses some of these crystals to season your food.



These cooled slowly

These cooled quickly

Most minerals are made up of crystals. These crystals are of different sizes. They have different shapes too. Each kind of mineral has a crystal shape of its own.

Salt crystals are usually boxlike in shape. Some minerals form crystals that have six sides. Others form crystals with eight sides. Other minerals have other shapes.

Sometimes minerals have large crystals. Sometimes they have small ones. When materials which contain minerals cool quickly, the mineral crystals are small. When the materials cool more slowly, the mineral crystals that form are somewhat larger.

You may wish to try making large and small crystals. You can do it in this way: Dissolve a tablespoonful of salt in about a half cup of boiling water. Put some of your salt water in a shallow dish and let it cool very slowly in a warm place. Put the rest of your salt water in another dish. Set it in a cool place.

Leave the dishes alone for several days. Crystals will form as the water evaporates. Are the mineral crystals that formed in one dish a little larger than those that formed in the other dish? Did larger crystals form in the dish that you put in a warm place?

Mineral crystals inside the earth form in much the same way. Larger mineral crystals form when the materials that contain minerals are cooled slowly. Smaller mineral crystals form when the materials that contain the minerals are cooled quickly.

Sometimes the materials cool so quickly that crystals do not form at all. This sometimes happens when lava from a volcano cools very, very quickly.

Some minerals are harder than others. We sometimes say that a mineral is soft. But this does not mean that it is soft like cotton or mashed potatoes. Soft minerals are not as soft as that.

Have you ever tried to scratch a mineral with your fingernail? Minerals that can be scratched with your fingernail are called soft minerals.

The lead in your pencil is a mineral. See if you can make a scratch on it with your fingernail. Now try scratching a piece of blackboard chalk. It is a soft mineral, too. Can you scratch it with your fingernail?

Some minerals are too hard to be scratched with your fingernail, but they can be scratched with a penny. Others are so hard that they cannot be scratched with a penny, but they can be scratched with a knife blade. Still other minerals are so hard that they will make a scratch on a piece of glass.

A diamond is a mineral. It is the hardest mineral we know. It is one of the minerals that will make a scratch on a piece of glass.

Minerals may be almost any color. Some are pink. Others are gray. Some are black. Others are purple or red or green. Still others are blue. People who study minerals use color as one way of telling one mineral from another.

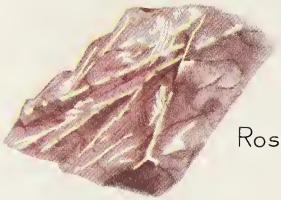
Can you find most of the colors mentioned here in the minerals near the place where you live? Perhaps you never thought of minerals as having so many colors.

Yes, minerals differ in many ways. They differ in size and shape of crystals. They differ in hardness. Some minerals are hard. Some minerals are soft. They differ in color too.

Cut diamonds

Minerals of many colors

Feldspar



Rose quartz

Some Common Minerals

Some minerals are found in many places. These are the common minerals. You can see these minerals in Canada. You can see them in Colorado. You can see them in Mexico. You can see these common minerals in other places on our earth.

Feldspar is the name of a very common group of minerals. You will be almost sure to find some around where you live. Feldspar is found in many, many rocks.

One thing that helps us to know feldspar is the way it breaks when hammered. The picture above on the left shows that it breaks into very thin, flat pieces. When you look at the surfaces of these pieces, you see that they are pearly.

Feldspar is a hard mineral. You could not scratch it with your fingernail. You could not scratch it with a penny.

You may want to try scratching feldspar with a piece of glass. Most feldspars are too hard to be scratched by a knife, but they can be scratched by a piece of glass.

Feldspar may be of different colors. The most common kinds are pink, white, gray, and yellow. One kind of feldspar is green. But green feldspar is found in only a few places.

Quartz is the name of another kind of common mineral. You have probably seen it also. It is found in many, many rocks.

Sand is usually made of quartz crystals. When you walk barefoot in the sand at the beach, you are really walking in quartz crystals. The sand you made mud pies with when you were smaller probably had quartz crystals in it, too. Does this help you to know how common quartz is?

Quartz crystals may be of different colors. Many of them are clear, like glass. Some quartz crystals are rose-colored. Still others may be smoky or milky. One kind of quartz is purple. It is used in jewelry. Purple quartz is called amethyst. Have you ever seen any jewelry with amethyst in it?

Quartz is one of the hard minerals. It is hard enough to make a scratch on a piece of glass.

Mica is another common mineral. It is found in many, many places. You may sometimes see it in rocks around you. It often sparkles in the bright sunlight.

Mica is a soft mineral. Usually you cannot scratch it with your fingernail, but you can always scratch it with a penny. You can sometimes separate layers of micas with your fingernail. You can peel off layer after layer if the piece of mica is big enough.

One layer of mica is thin enough to see through. It may look almost as clear as a piece of glass. Sometimes mica is not so clear as that. It may be black mica.

You may have seen pieces of mica in the door of a coal stove. The little windows in the door are made of mica. You can look through these little windows of mica and see the fire burning brightly inside the stove.

From Plants to Coal

Coal is a mineral. Do you know the story of how it was made? The story goes something like this: Long, long ago great, hot, wet jungles like the one you see here covered some parts of the earth. Giant ferns, tall trees, and other plants grew in these jungles. These giant plants died and fell into the swamps, where they were buried deep in the mud. Here they stayed for a long, long time.

As time went on, more plants grew tall and died and fell into the mud. Layer upon layer of plants piled up in the muddy ooze of the swamps. The top layers of dying plants pressed on the layers below them. The ferns, trees, and other plants were squeezed together and cemented by the mud.

What was once living material was now being made into the hard, rocklike material which we call coal. Perhaps you have seen pieces of coal which have prints of fern leaves in them. These prints are called fossils. They are pictures of leaves that grew on the trees which were buried in the coal-making swamps.

Sometimes pictures of sea shells are found in coal, too. These fossils show that salt-water animals were once trapped in the muddy places where coal finally formed. The places where these swamps formed were once part of the ocean bottom.

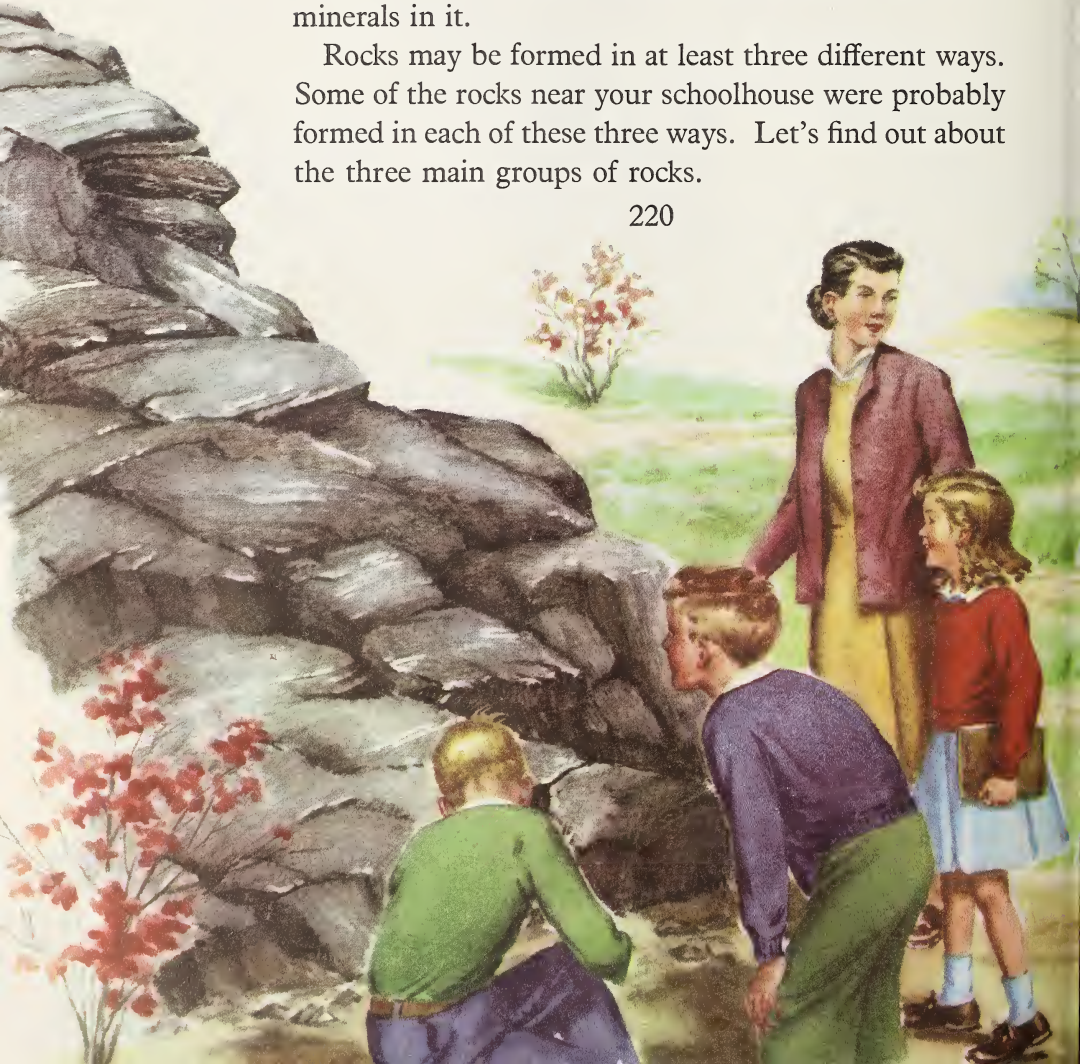
This story of how coal was made may seem strange to you. Plants that once lived on our earth now heat some of our homes. They run some of our ships at sea, too. Yes, once-living plants made the rocklike coal we use today.

Learning about Rocks

Rocks make up the solid part of the earth. They are mixtures of minerals. One piece of rock may have quite a few kinds of minerals in it. Or it may have only one or two minerals in it.

Look at a piece of rock. See if you can find different kinds of minerals in it. The different colors in the rock may help you to know that it has different kinds of minerals in it.

Rocks may be formed in at least three different ways. Some of the rocks near your schoolhouse were probably formed in each of these three ways. Let's find out about the three main groups of rocks.

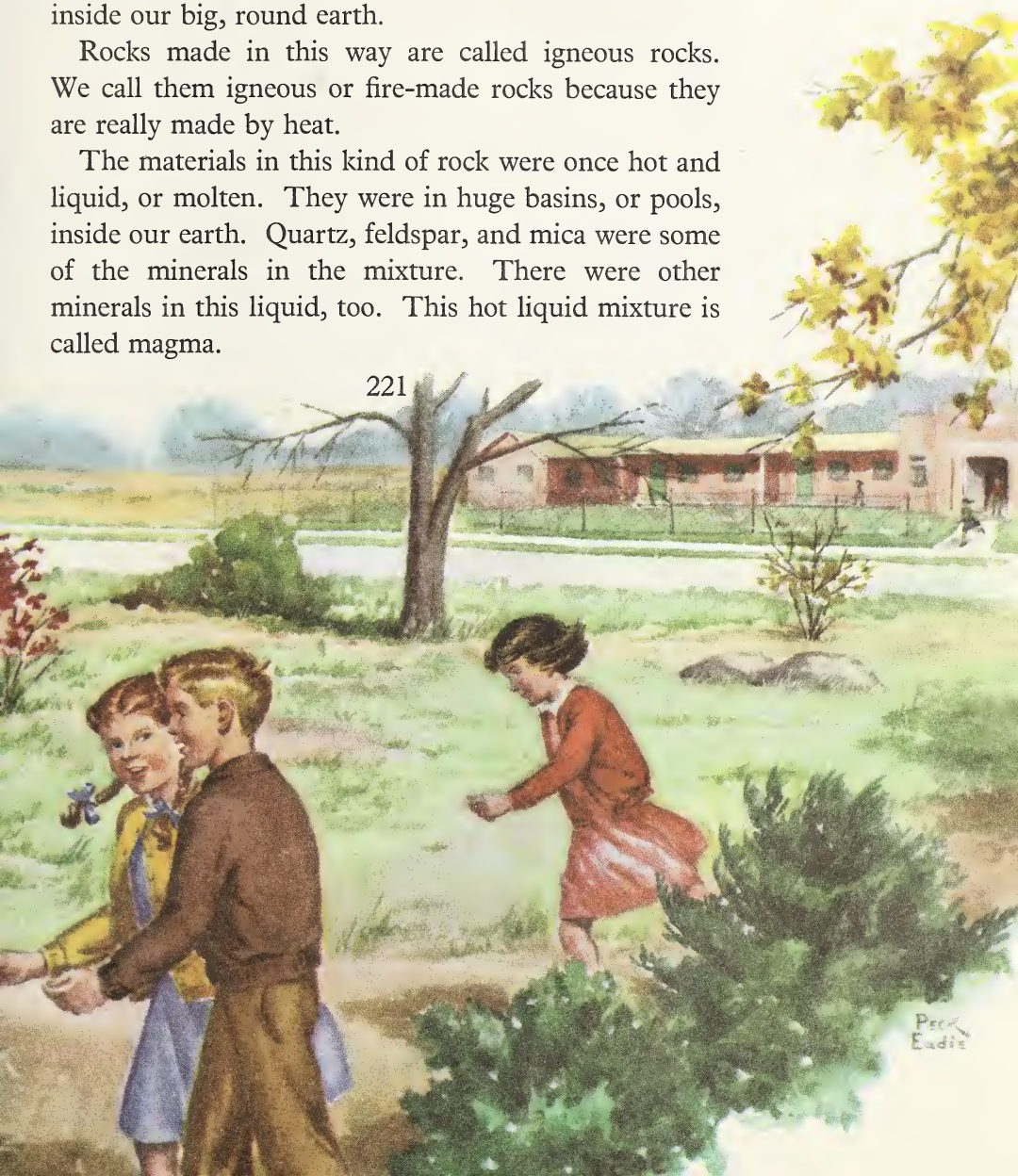


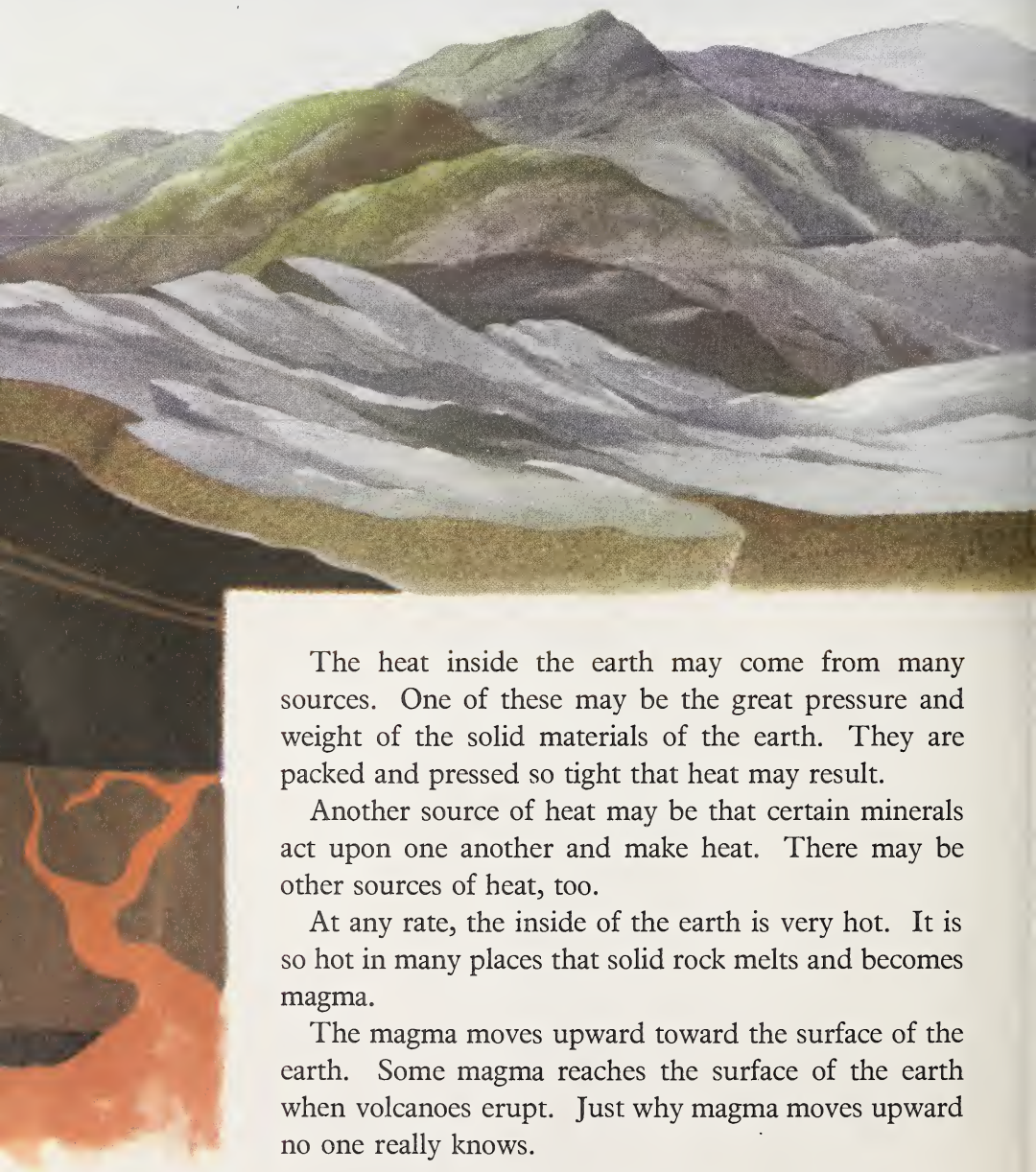
Finding Out about Fire-made Rocks

The rocks of the first group that we shall read about have all been made by heat. They were heated deep inside our big, round earth.

Rocks made in this way are called igneous rocks. We call them igneous or fire-made rocks because they are really made by heat.

The materials in this kind of rock were once hot and liquid, or molten. They were in huge basins, or pools, inside our earth. Quartz, feldspar, and mica were some of the minerals in the mixture. There were other minerals in this liquid, too. This hot liquid mixture is called magma.





The heat inside the earth may come from many sources. One of these may be the great pressure and weight of the solid materials of the earth. They are packed and pressed so tight that heat may result.

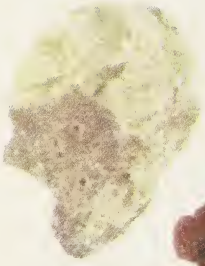
Another source of heat may be that certain minerals act upon one another and make heat. There may be other sources of heat, too.

At any rate, the inside of the earth is very hot. It is so hot in many places that solid rock melts and becomes magma.

The magma moves upward toward the surface of the earth. Some magma reaches the surface of the earth when volcanoes erupt. Just why magma moves upward no one really knows.

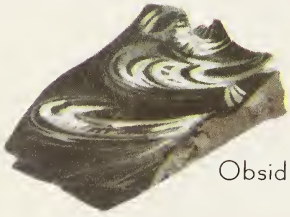
Some people who have studied this problem believe that the molten mass may melt the rocks above it. Also, we know that there are gases and steam inside the earth. These come out as a volcano erupts. Some people believe that these gases and steam can press hard enough on the rock layers to cause them to give way. This also would make room for the molten mass to move upward.

Really only a little of the great molten masses of rock ever reaches the surface. Much of it flows beneath the surface of the earth, upwards and sideways, and is pressed into cracks between solid layers of rock. Here it cools and hardens and becomes rock.



Pumice

Lava



Obsidian

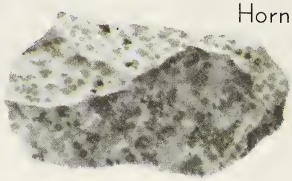
The magma that flows out of a volcano is called lava. It is liquid rock. As it cools, it becomes hard, fire-made rock.

The pictures on this page show you some kinds of fire-made rock. One piece looks like glass. Another piece has many little holes in it. It may make you think of the egg white on top of lemon pie. Both these kinds of rock were once lava, or liquid rock.

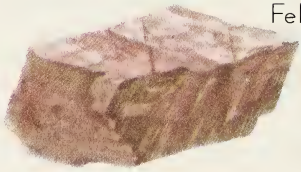
Granite is one of the most common igneous, or fire-made, rocks. It is always formed underground. None of it flows out of a volcano, as lava does.

Granite forms only when magma cools very, very slowly. As magma cools, the minerals in it separate from one another and form crystals. The mixture of minerals which hardens into granite always has quartz and feldspar in it. It usually has two other minerals in it also.

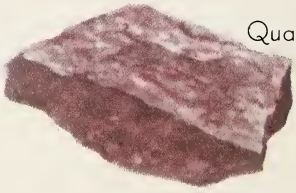
As you look at a piece of granite, you usually think it looks speckled. It has different colors in it. The feldspar and quartz crystals in it may be pink or white or gray or green.



Hornblende



Feldspar



Quartzite

Sometimes shiny crystals of mica are mixed in with the other minerals in granite. The black specks in granite may be crystals of black mica. Or they may be crystals of a black mineral called hornblende.

Granite is a hard rock. It is used for many purposes. Look around where you live and see if you can find granite being used.

Many bridges are made from granite rock. Are there any bridges in your neighborhood that are made of granite?

Often you will find monuments in parks and along roadsides. Some of these will probably be made of granite.

They may look different from the granite used in bridges. The granite used in monuments usually has been polished, so that it looks smooth and shiny.

Granite is used in many buildings too. Are there any buildings in your neighborhood that are made partly of granite? It is a useful rock because it is so hard.

Finding Out about Sedimentary Rocks

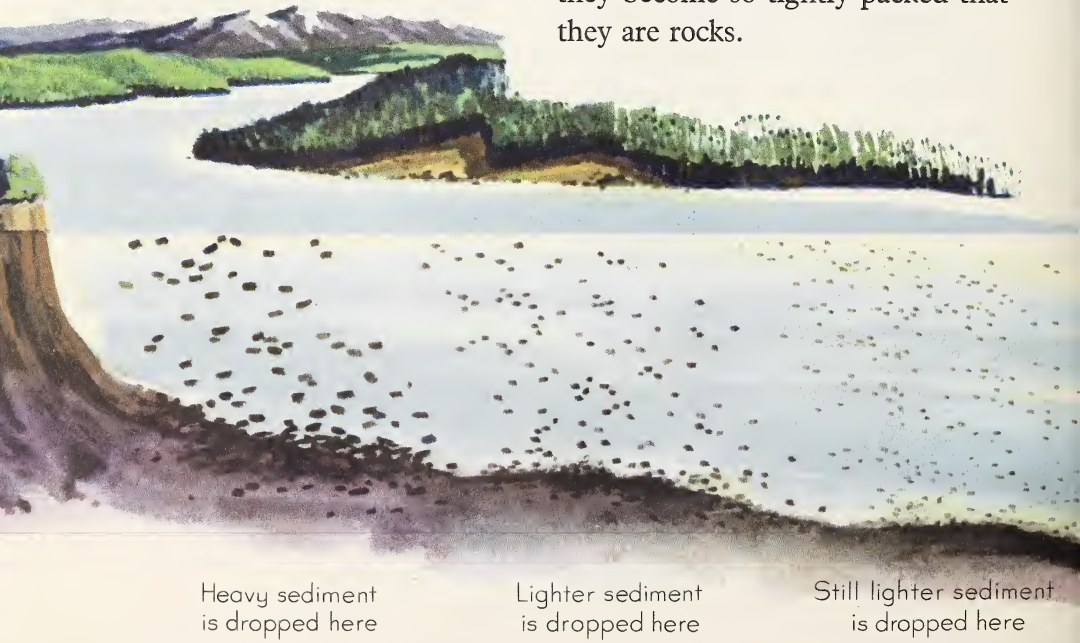
Most of the rocks in the second main group have been formed under water. Day after day brooks, streams, and rivers run along and finally empty into the oceans. Day after day the waters of these thousands of streams carry small bits of rock and soil into lakes, seas, and oceans.

Every time it rains, the streams get brown and dirty. Rain brings loose material from the fields to the streams. During rainy times streams carry much loose rock and soil down to the oceans.

As the streams empty into the lakes, seas, and oceans, they drop much of their load. The heavy pebbles and loose gravel drop first. They drop near the mouths of the rivers. Lighter material, sand and clay, is carried farther out before it is dropped.

Year after year and century after century soil and pebbles keep being carried out to sea. There they are dropped to the bottom.

These layers of material become heavier and heavier. The materials get packed and pressed together. Finally, after many, many centuries, they become so tightly packed that they are rocks.



Rocks formed in this way are called sedimentary rocks. They are made from material, or sediment, dropped on lake and ocean floors.

Most sedimentary rocks are formed under water. But some sedimentary rocks are formed in another way. Some are formed by the winds. The winds may carry bits of soil and sand about. Finally, they deposit them. These deposits may in time develop into sedimentary rocks.

You can do an experiment and see how some sedimentary rocks are formed. Put a handful of soil and pebbles into a glass jar half full of water. Screw the top on well. Then shake the jar. The water will become muddy.

Now set the jar on the table and watch to see what happens. Does the heavy material settle first? How long does it take for the water to become clear again? Can you see layers of soil in the bottom of the jar?

Of course the layers of soil in your glass jar do not turn to rock. They are not packed hard enough for that. There is not enough pressure. But you can see how layers of loose material are laid down on the ocean floor.

You may wonder how the rock that was formed under water gets out from under it. How does it get into your schoolyard? How does it get into the park in the city? Some of it may be found on the tops of mountains. Some of this rock may be found in your flower garden if you have one. How did it get there?

Do you understand that mountaintops may at one time have been under water? Do you understand that your schoolyard may at one time have been under the sea? The very spot where your home now stands may once have been under water, too.

Land may move upward when earthquakes shake the earth. It may also move upward when volcanoes erupt. Other strong forces inside the earth may move the land upward, too.

Waters of lakes and seas may dry up also. The rock layers that were once below water are now on top of the ground.

Many, many places that are now dry were once covered by the waters of lakes, seas, or oceans. Do you suppose the place where you live was once under water at the bottom of the sea?

One kind of sedimentary rock is made mostly of sand grains. It is called sandstone. It may have been made from small bits of sand carried by water and finally dropped to the ocean floor.

It may also have been made by bits of sand carried about by winds and finally dropped in one place. The beautiful sandstone rocks of Zion Canyon in Utah were formed in this way.

Sandstones of many colors are found in many parts of the world. The Grand Canyon of the Colorado River is cut through layers of many-colored sandstones.

Shades of red, orange, yellow, blue, and purple make this great canyon one of the most beautiful sights you will ever see. The different colors come from different materials in the rock. Iron is one of these materials.

You can sometimes tell sandstone from other rocks by the way it feels. You can often feel the grains of sand. You can often break it into pieces by pressing it in your hands. It is a soft rock.

You remember that as streams flow into the sea, pebbles drop to the bottom of the sea first. They form coarse rock. You can see coarse rock called conglomerate in the picture at the right. You may find a piece of conglomerate rock sometime. It may have quite large pebbles cemented into it. You will know that it was formed under water.

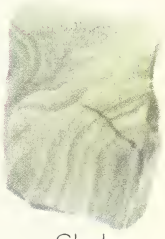
Sediment that is very, very fine is carried farther out to sea before it is dropped. Clay and mud dropped to the ocean floor form a rock called shale.

You can tell shale when you see it because it looks like hardened clay and mud. It is always in layers. The layers in shale help you to know that it was made under the sea. Sometimes it is easy to split the layers of shale apart.

Look and see if there are any banks of shale near your home. Roads are often cut through hills. Sometimes when you drive through the hills, you can see shale banks on each side of the highway.

Sandstone

Conglomerate



Shale

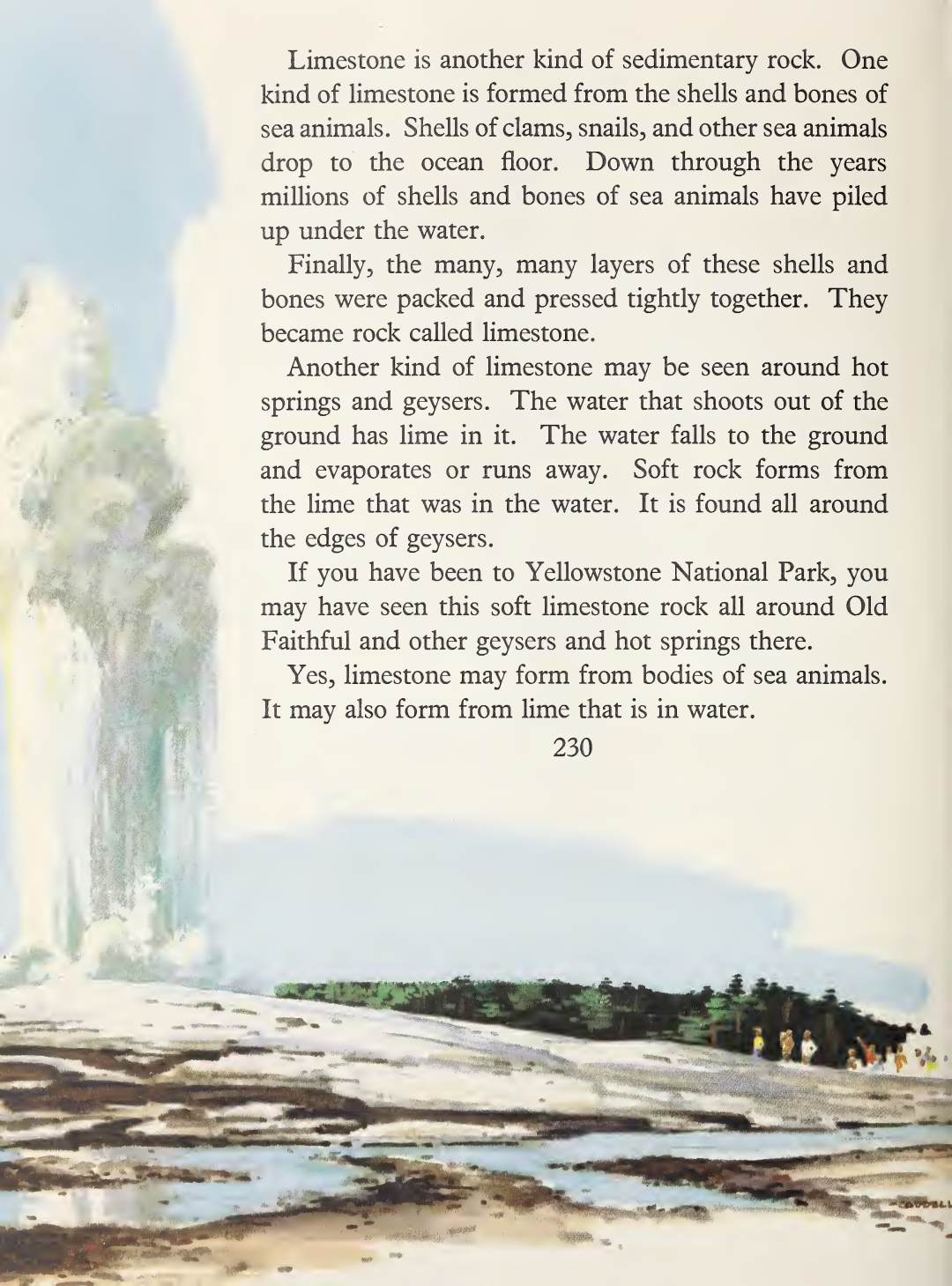
Limestone is another kind of sedimentary rock. One kind of limestone is formed from the shells and bones of sea animals. Shells of clams, snails, and other sea animals drop to the ocean floor. Down through the years millions of shells and bones of sea animals have piled up under the water.

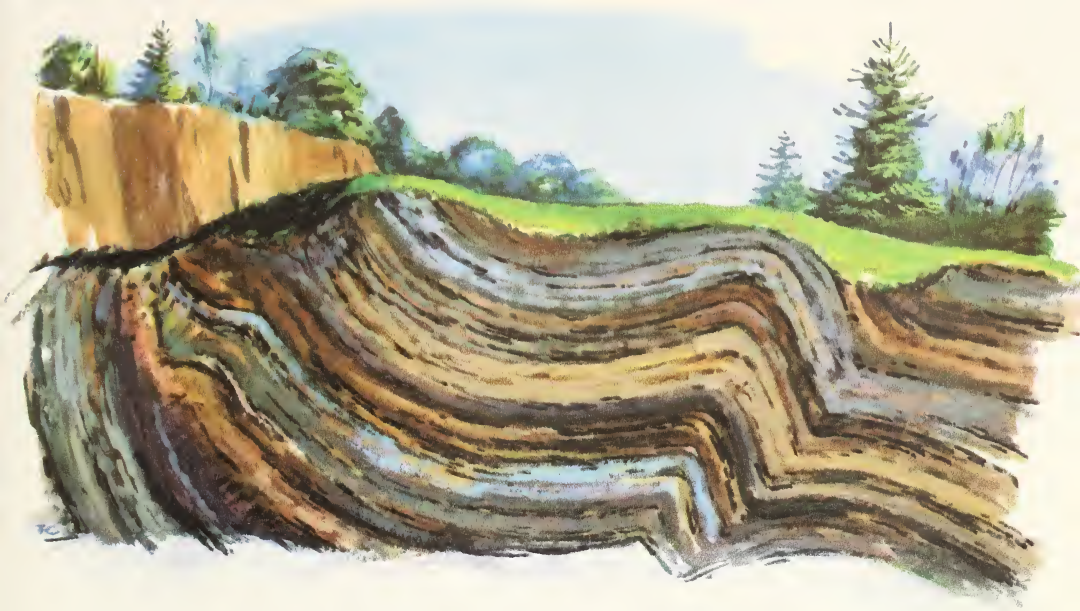
Finally, the many, many layers of these shells and bones were packed and pressed tightly together. They became rock called limestone.

Another kind of limestone may be seen around hot springs and geysers. The water that shoots out of the ground has lime in it. The water falls to the ground and evaporates or runs away. Soft rock forms from the lime that was in the water. It is found all around the edges of geysers.

If you have been to Yellowstone National Park, you may have seen this soft limestone rock all around Old Faithful and other geysers and hot springs there.

Yes, limestone may form from bodies of sea animals. It may also form from lime that is in water.





Finding Out about Made-Over Rocks

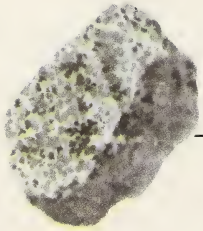
You have been reading about two of the three ways in which rocks are formed. Now let's read about the third way.

You remember that igneous rock is rock made from magma, which formed inside the earth. Sometimes the magma flowed upward and sideways and was pressed between layers of rock around it. But sometimes there were no cracks into which the magma could flow. When this happened, the pressure became so great that the rocks themselves became changed.

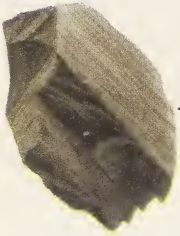
Sometimes rocks were changed by pressure or heat. Other rocks may have been changed by water. Whole layers of rock were often folded and changed. We say the rocks were made over. Changed, or made-over, rocks are called metamorphic rocks. Look carefully at the picture on this page. Can you see that the rock layers have been folded?

You may want to know how some of the rocks you have been reading about change. Look at the pictures on the next page to find this out.

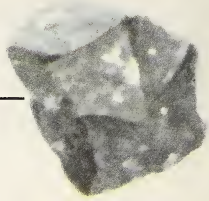
New Rocks from Old

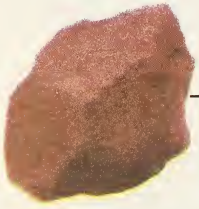


Granite changes to gneiss.

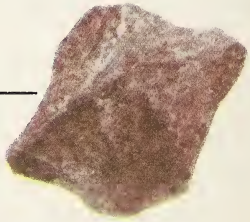


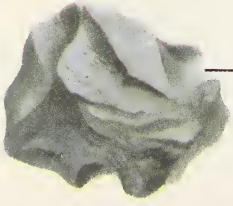
Limestone changes to marble.



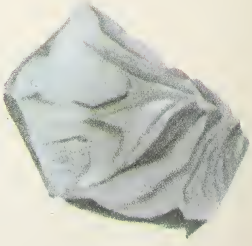


Sandstone changes to quartzite.





Shale changes to slate.



This idea may seem funny to you. But every time you sit down to eat your supper or lunch or breakfast, you eat some kinds of foods that contain minerals. You have been reading about minerals in the earth. Certain substances in our food are called minerals, too.

We might almost say, "Please pass the iron," when we ask for a second helping of lamb chops and potatoes. We might almost say, "We eat iron," as we eat a handful of raisins. Liver, prunes, eggs, and lean meat are rich in iron, too.

Of course we do not eat a *piece* of iron when we eat these foods. What we really mean is that we eat food containing iron.

When we drink a glass of cold milk, we drink a liquid that has calcium in it. Calcium is needed for building good bones and teeth.

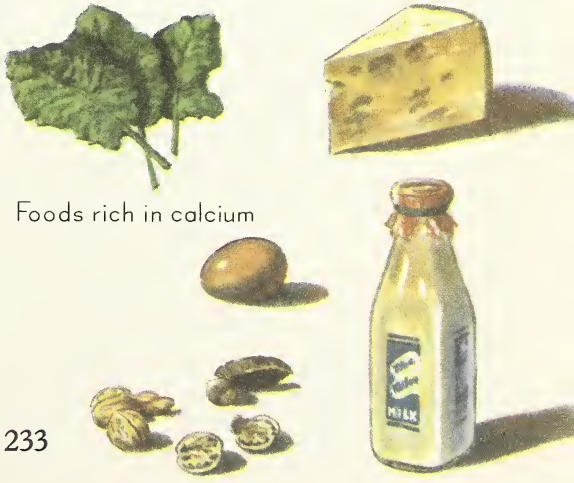
When we eat a cheese sandwich for lunch, we are eating foods that contain minerals our bodies need.

Do you enjoy a nice piece of broiled fish with lots of butter on it? Fish and butter also contain minerals that the body needs.

The minerals in your food were part of the food that the plants and animals which you eat used. You eat the food and get the minerals. You need only a little of each of these minerals, but you cannot stay healthy without calcium, iron, and other minerals.

Foods rich in iron

Foods rich in calcium



Minerals We Wear

Not only are minerals eaten by us, but some of them are worn. Much of our jewelry is made of metals and minerals.

We use gold, copper, and silver for rings, necklaces, pins, and earrings. Crystals of quartz, rubies, garnets, and diamonds are often set in one of these metals. This makes the crystals more beautiful.

People of all countries, and of ancient as well as modern times, have used jewelry.

The Indians of the southwestern part of the United States are well known for their handmade silver jewelry, set with beautiful, blue mineral crystals.

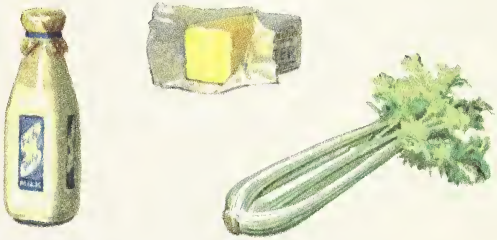
Diamonds and rubies are called precious stones because they are less common minerals. Others are called semi-precious stones because they are much more common. Garnets and purple quartz are semi-precious stones. They are found in many places.

1. Rocks take a long, long time to form. They help us to understand that our earth is old. It is old enough for rocks to have formed under the sea. It is old enough for hot liquid material inside our earth to have cooled and hardened. It is old enough for parts of the earth to have risen above the sea. It is even old enough for rocks that have formed inside our earth to have been heated and melted and hardened again. Yes, rocks help us to know that our earth is very old.

2. Look around in your neighborhood and think and talk about what your part of the earth may have been like long, long ago. Are there any mountains to talk about? Are there any swift rivers flowing toward the sea? Are there deep canyons that were made by swift-flowing streams?

3. There may be some place near your school where men are working on a road or starting a cellar hole for a new building. Can you go there several different times as the men dig deeper into the ground? Look carefully and talk about the different kinds of rocks that you see there. What do these rocks tell you about the earth where you live?

4. The minerals you eat help you to grow strong and healthy. The pictures below show you some foods that supply minerals to your body.



Foods containing calcium

Foods containing iron

Foods containing iodine and salt

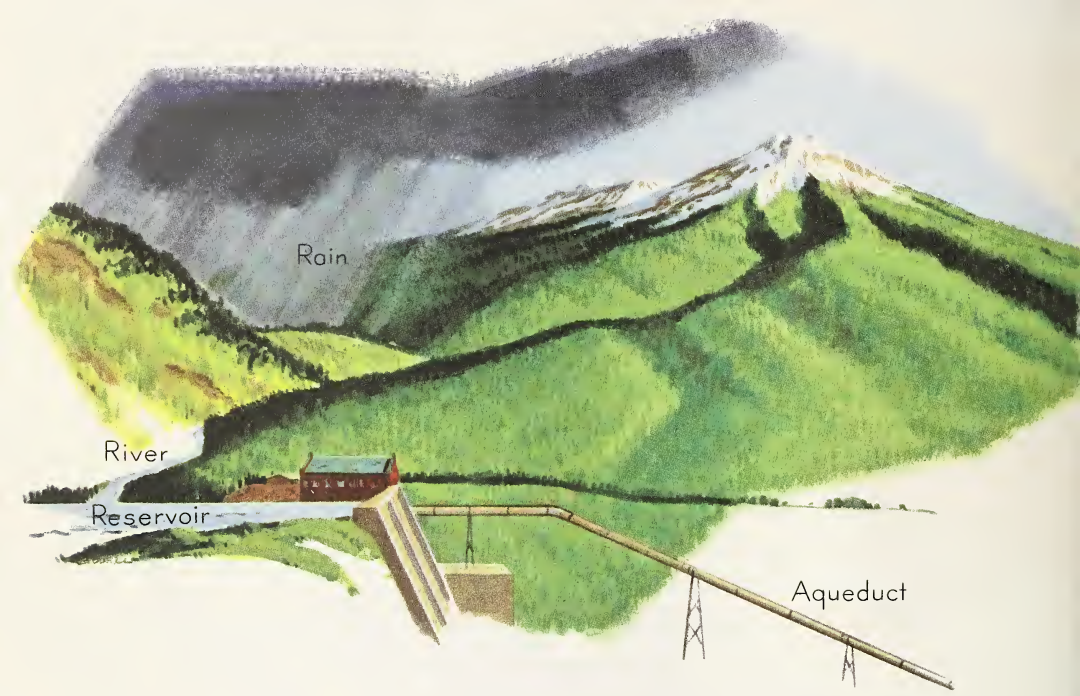
Using Materials Wisely

"Waste Not, Want Not"

The saying above is one that you have heard many times. It has to do with using materials wisely. It has to do with being sure to save some of our minerals and other materials for the people of tomorrow.

People all over the world have sometimes not been very careful about using materials wisely. They have wasted water by polluting it. Many plants and animals that live in water die when it becomes polluted. People have sometimes wasted good topsoil by poor ways of farming. They have sometimes wasted forests by cutting down many, many trees. Fires due to carelessness destroy many forests, too.

People have also wasted the treasures inside the earth. These materials include coal and iron. They include oil and natural gas too.



Using Water Wisely

Water is very important to all living things on earth. Perhaps you live in a place where it rains or snows often. There is no shortage of water where you live.

But how about the many places on this earth where there isn't enough water? It rains only a little each year.

When you live in places where water is scarce, you know how important water really is. Plants do not grow well. Grass wilts. Animals have to be watered from deep wells. Water has to be pumped from these wells.

Some dry places in your country are now irrigated. Water is stored in large reservoirs behind great dams. Then the water is used when it is needed.

Sometimes a big ditch goes all along one end of a field that is to be watered. Smaller ditches run down between the rows of crops. Water is then pumped into the big ditch at the end of the field. Then the farmer opens the ends of the ditches between those rows that need water.

The ground gets well soaked, and water stands in the row ditches. Then the farmer closes the ends of the ditches. He often does this by simply pushing dirt into the end of each ditch.

Perhaps you have ridden along a road in the dry part of your country. All at once you came upon a great stretch of orchard. You looked for the irrigation ditches. You knew that these orchards could grow in such dry places only because water had been saved in reservoirs for them.

Yes, water is important. We must use it wisely. We must learn better ways to save it for later use.

Wasting the Wealth in Water

Perhaps we had better look at how well we are using the wealth of the waters of the earth. Are we taking care to use it wisely? Are we making sure that the waters of the earth will keep on being a mighty storehouse for food?

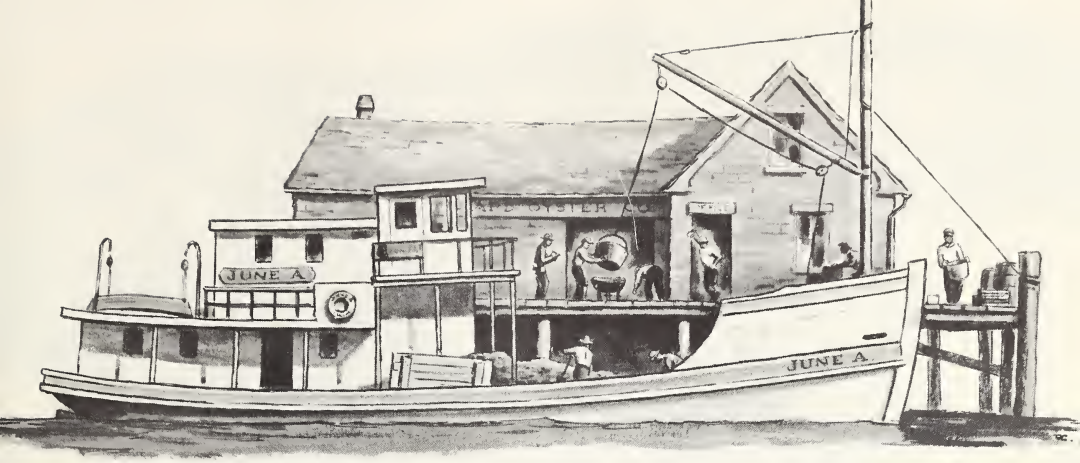
One way to find out about how wisely we are caring for our oceans, lakes, ponds, rivers, and brooks is to look around us in our own neighborhoods to see just what is happening there.

John lives near the ocean. He lives at the mouth of the Hudson River in New York City. The tides go in and out at the mouth of this great river and carry salt water far up the river.

John goes often to watch the boats in New York harbor. He likes to imagine himself as the captain of a busy tugboat pushing a great ocean liner into dock. He likes to make believe he is loading the hold of a boat with grain or ore.

Surely this harbor is a very busy place. But John sees some things which he does not like. The harbor is a dirty place. There are many wooden boxes, empty cans, bottles, boards, and other things floating in the harbor.

John doesn't like the idea of throwing such things into the harbor. He believes that people should help to keep the water in the harbor clean.



Oystermen unloading their catch

John is right. All of us should help to keep the water in lakes, rivers, and oceans clean. First of all, it is healthier and pleasanter for all of us to have clean water to look at and swim in.

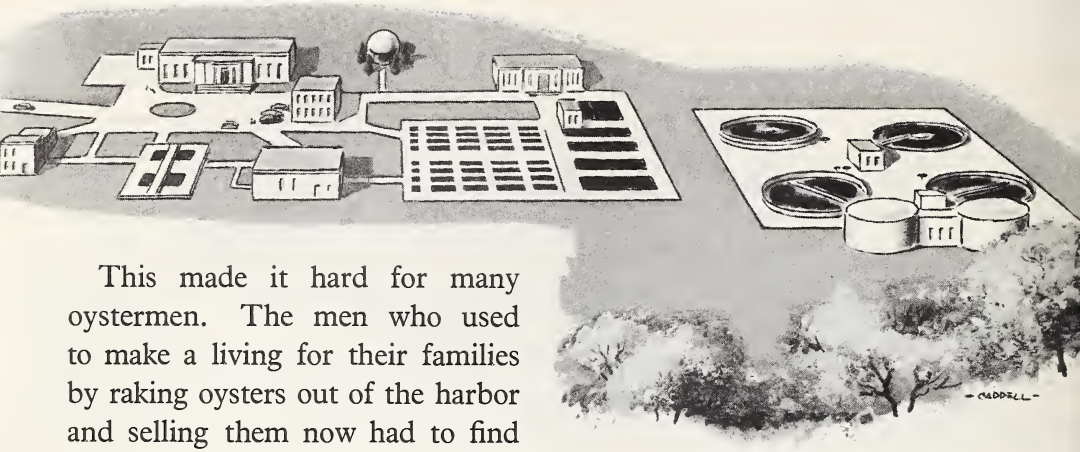
But clean water is needed most of all so that hundreds of fish and other animals can live in it.

You remember that the waters of our earth are a mighty storehouse for food. Much of this food cannot keep alive in dirty water. In fact, right now there is not nearly so much food in our lake and ocean storehouses as there once was. This is because of the way we have let the water get dirty.

Let's think a moment about John's harbor. Once New York harbor was rich in oyster beds. They reached up the Hudson River for miles. Oystermen lived along the shore and made a good living gathering oysters and selling them in nearby fish markets.

This is no longer true. The harbor has become dirty. We say the water of the harbor is polluted. The oyster beds became polluted, too. People who ate oysters from these beds became ill.

The New York City Health Department had to stop the oystermen from gathering oysters. They were no longer allowed to get oysters from the polluted beds. The beds themselves were raked and most of the oysters destroyed.



Sewage-disposal plant

This made it hard for many oystermen. The men who used to make a living for their families by raking oysters out of the harbor and selling them now had to find other work to do.

But oysters are not the only animals that used to live in John's harbor and are not there now.

Lobsters used to be caught in large numbers in New York harbor. Mackerel, by the millions, used to run up the Hudson River. Mackerel still run up the river, but not millions and millions of them. There are not nearly that many any more. The harbor is too polluted to suit mackerel. It is also too polluted for many other kinds of fish.

What has happened to New York harbor is serious. It will take a long time to correct matters. But New York is already at work on this job. It is building more sewage-disposal plants. John hopes that he will soon see a clean harbor when he goes to watch the boats.

This same thing has happened in many other harbors. Places once full of water animals now have fewer of them because the waters are polluted.

In some places sewage from towns and cities runs directly into streams. This, of course, pollutes all the water. Cities and towns that empty their waste materials into streams should be made to treat these materials to kill the germs which are harmful to most water plants and animals.

Only in this way can we hope to keep our streams and oceans clean enough for animals and plants to live in. Only then can the waters of the earth keep on being a mighty storehouse for food.

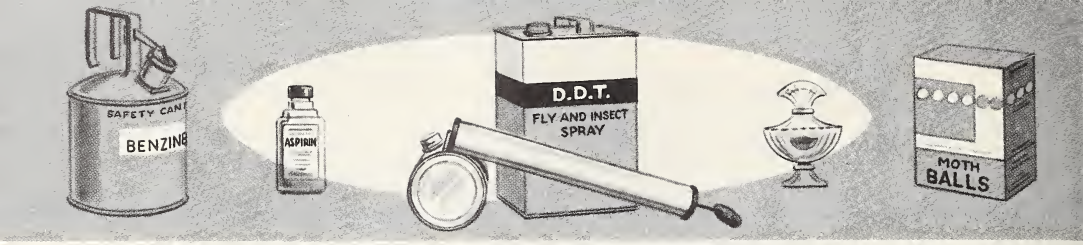
Coal Is a Hidden Treasure

Hidden away inside the earth is a great storehouse of treasures. They are treasures because they are so very useful to man. Our lives would be very different if no one had learned to use these treasures of minerals and other materials.

We think that it is a good thing that people learned to use the treasures which they found inside the earth. Take coal as an example. Using coal for fuel has made a great difference in our lives. Huge coal-burning furnaces do useful work.

Coal heats water to make steam to heat many homes, schools, and offices. Coal heats water to make steam to run machines which make electricity. It heats water to make steam to run locomotives.

Coal can also be made to give up the gas that is stored in it. Your mother may use this gas to cook your supper. Much of the hard coal which is mined is used to make the gas used for cooking. Does your mother cook with gas?



Did you ever hear of coal tar? It is a black, sticky liquid which comes from coal. It is used to make many useful things. The pictures on this page show you some of the products made from coal tar.

No one knows just how much coal there is left inside the earth. At one time there seemed to be enough to last for a long, long time. There is still a great deal of coal inside the earth. Also, coal is still being formed, ever so slowly, in some places on the earth. It is forming slowly in the great swamps of North Carolina and Virginia.

In these places there is a layer of peat several feet thick. If we leave it alone and do not use it, after a long, long time it will become coal.

We are in no danger of running out of coal tomorrow or next month or next year. Men who have studied our coal supplies believe there is enough coal to last thousands of years. Perhaps there is enough to last much longer.

Since we know that it takes so very, very long for coal to form, however, we need to use every bit of it wisely.

It is important to learn how to run our coal furnaces so that no fuel is wasted. We often burn more coal than is needed to keep our homes warm. When we do, we waste coal, which may be greatly needed elsewhere.

Oil Is a Hidden Treasure

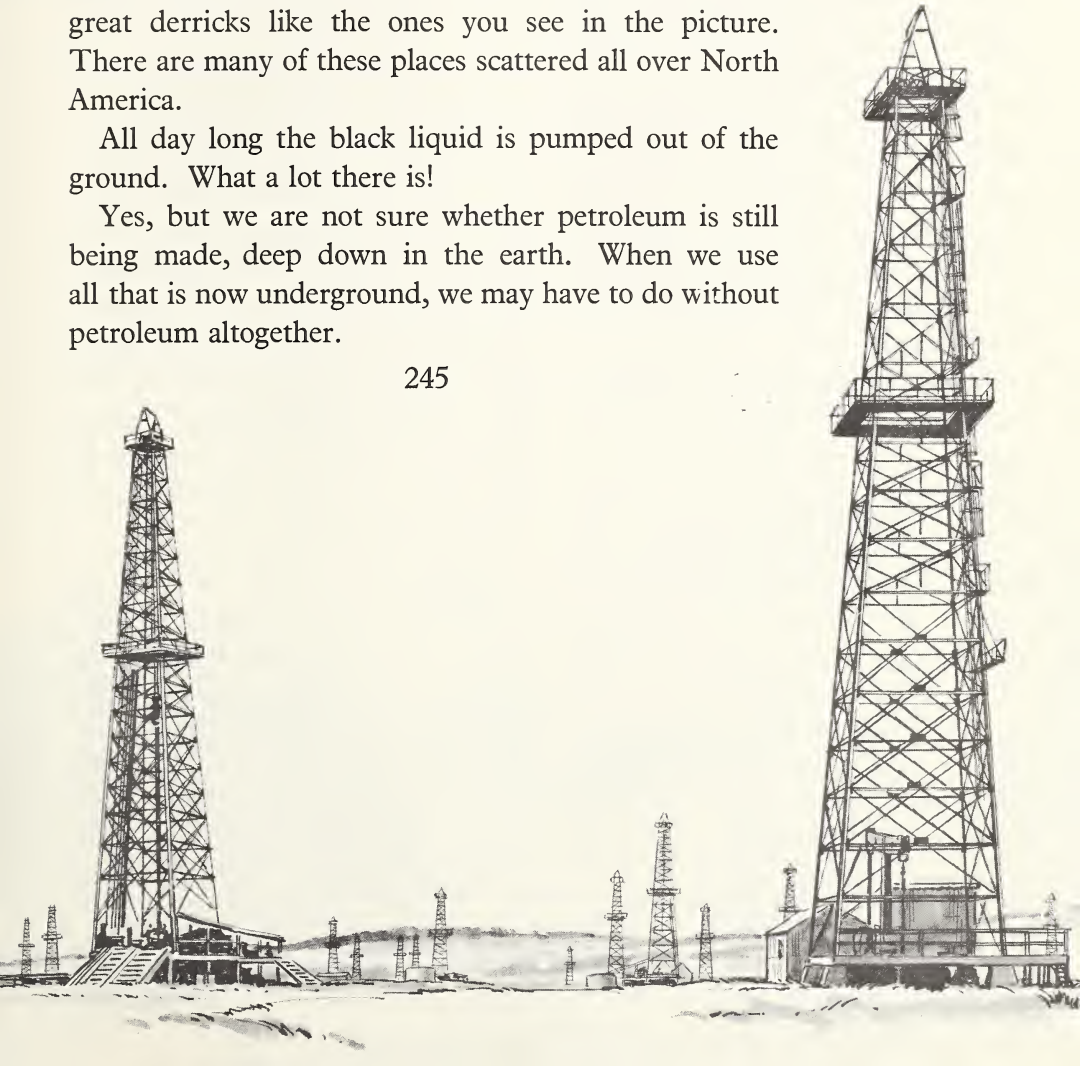
Sometimes we forget how important the oil is that comes out of the ground. Yet here, again, our lives are very different because of it.

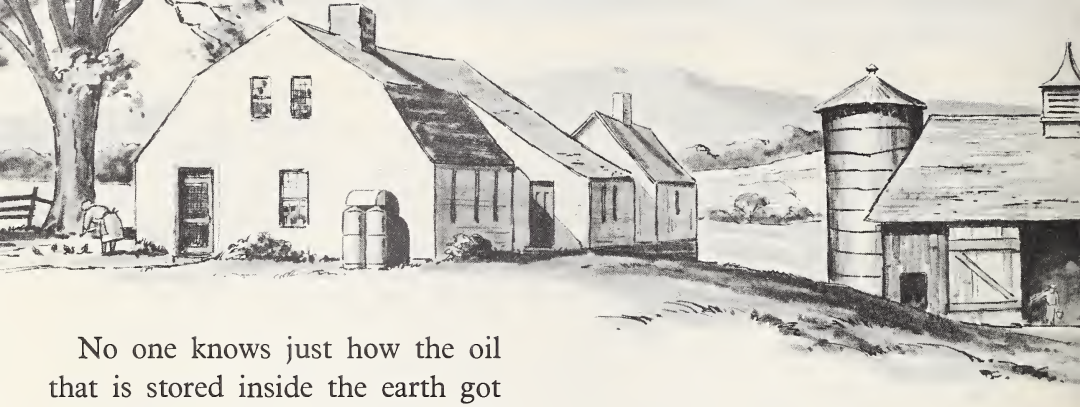
Let's call this thick, black liquid by its right name. It is petroleum. As it comes from the ground, it is called crude oil.

You may have traveled to places where there were great derricks like the ones you see in the picture. There are many of these places scattered all over North America.

All day long the black liquid is pumped out of the ground. What a lot there is!

Yes, but we are not sure whether petroleum is still being made, deep down in the earth. When we use all that is now underground, we may have to do without petroleum altogether.





No one knows just how the oil that is stored inside the earth got there. We know that oil is found only where seas once were.

Men who have studied this subject think that oil came from the plants and animals which once lived in those seas. We know that this black oil lies trapped beneath the surface of the earth in many, many places.

Oil from the great oil fields is brought to the top of the ground and sent to refineries, where it is made into many products. Some of it is sent in huge pipelines for hundreds of miles to refineries far away. The Big Inch pipeline is thousands of miles long. It reaches from Texas to New York.

Do you know how many different products are made from petroleum? There are many. As petroleum is heated, these products are separated from the crude oil.

One product is bottled gas, which you may use on your farm or at your cottage. It is a part of crude oil. It changes from a liquid to a gas when the crude oil is heated. It is then stored in large metal bottles. Your mother may use it for cooking.

The next time you drive through the country, keep looking for bottled gas outside of farmhouses. Then think that this gas was once part of the crude oil that formed down inside the ground.

Does your mother ever send suits and coats to the cleaners? Have you smelled them just after they were returned? There is often an odor somewhat like the odor of gasoline. The odor is naphtha. Naphtha is good for cleaning clothes. It, too, was separated from crude oil.

Your mother may use a cleaning fluid at home. She may clean some of her dresses and your father's suits at home. The cleaning fluids she uses are products of petroleum. Some of them explode easily; so they must be used very carefully.

Perhaps you live where kerosene lamps are used. Kerosene is separated from petroleum, too. Is kerosene used in your part of the country either for fuel or for lamps?

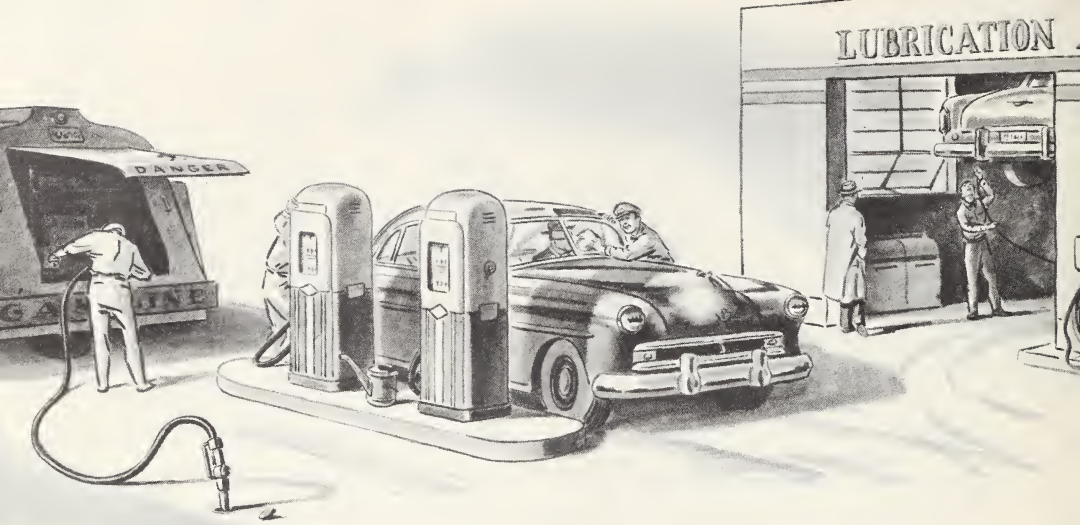
Some of you may live in a house that is heated by oil. If you do, you often see a big oil truck drive up. The driver unwinds a rubber hose and fills your oil tank. We call this product of petroleum fuel oil. Instead of heating your house with a coal furnace, you use an oil-burner.

Fuel oil also runs many locomotives and ships. These locomotives and ships have diesel engines in them. Fuel oil runs these engines.

Many different kinds of oil come from petroleum. What do you do when your wagon wheels squeak? Do you get out an oilcan and oil them? Mother oils her sewing machine, and Father gets the family car oiled and greased.

Every piece of machinery that has metal parts that move has to be oiled. Tractors, refrigerators, airplanes, motorboats, busses, and sewing machines all need oil.

Now can you see why our lives are different because of petroleum?



You may live where roads are made of asphalt. When it rains, these roads are slippery. Your father has to drive very carefully on these roads. Some of the asphalt used to build roads is made from petroleum.

The shingles on your schoolhouse may be asphalt shingles. Look and see if they are.

Gasoline is perhaps the most important of all petroleum products. Every hour thousands of gallons of gasoline are being used to run engines doing all sorts of work. Each year more and more gasoline is needed. Do we have enough to last forever?

No one can answer that question and be sure he is right. No one really knows for sure just how petroleum is formed. We are not sure it is being formed today.

At any rate, people who have studied this problem believe that petroleum is being used faster than it is being formed. If this is true, we must use what we have with great care.

We have been using petroleum for only about one hundred years. During that time much has been wasted that might have been saved.

In the past, fires at the oil fields have destroyed millions of gallons of oil and gasoline. Today, however, safety devices prevent most oil-well fires.

Natural Gas Is a Hidden Treasure

Natural gas is usually stored under the ground in the same places that petroleum is stored. However, this is not always the case. Natural gas may be found in places where there is no petroleum.

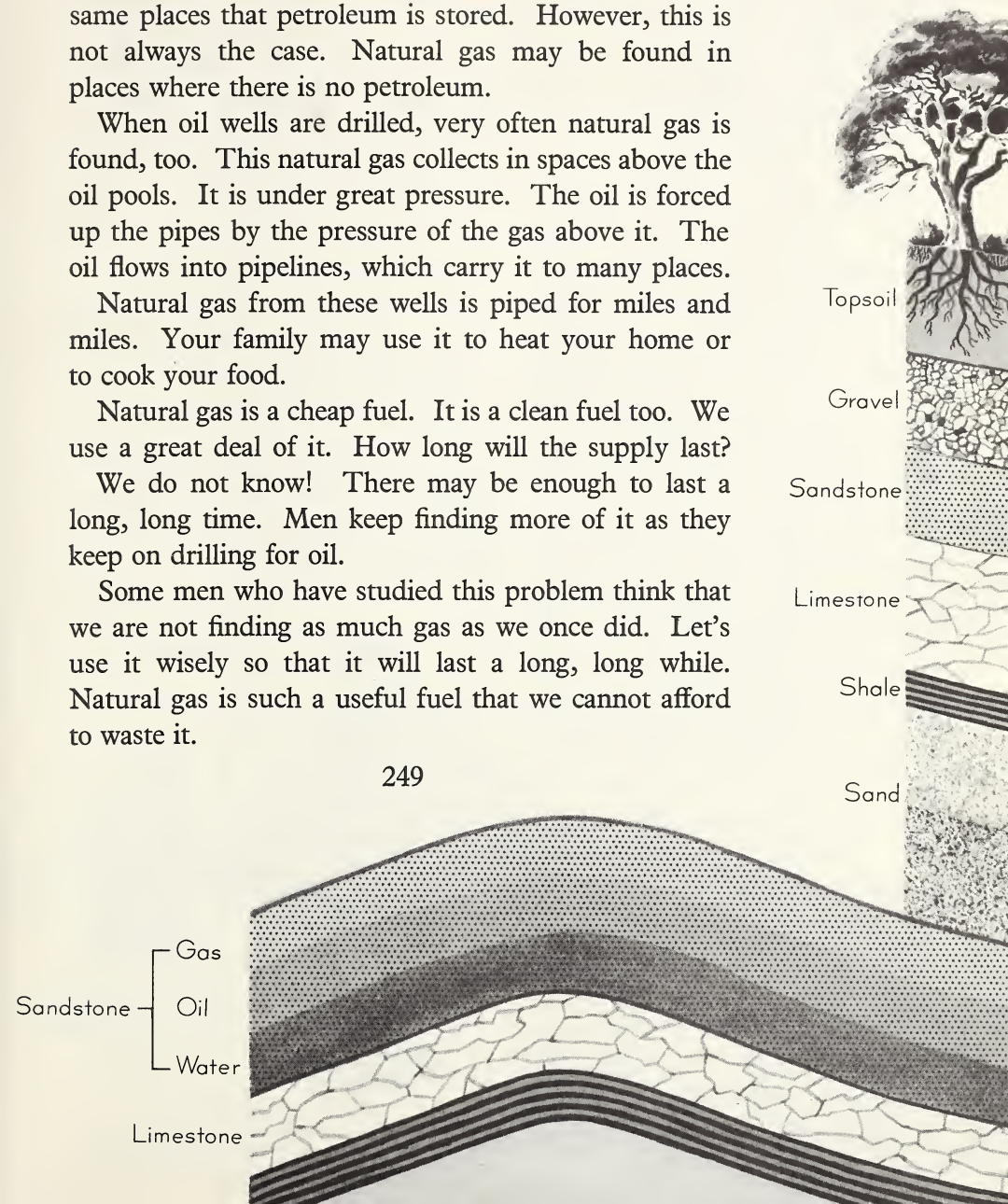
When oil wells are drilled, very often natural gas is found, too. This natural gas collects in spaces above the oil pools. It is under great pressure. The oil is forced up the pipes by the pressure of the gas above it. The oil flows into pipelines, which carry it to many places.

Natural gas from these wells is piped for miles and miles. Your family may use it to heat your home or to cook your food.

Natural gas is a cheap fuel. It is a clean fuel too. We use a great deal of it. How long will the supply last?

We do not know! There may be enough to last a long, long time. Men keep finding more of it as they keep on drilling for oil.

Some men who have studied this problem think that we are not finding as much gas as we once did. Let's use it wisely so that it will last a long, long while. Natural gas is such a useful fuel that we cannot afford to waste it.



Are We Using the Metals of Our Earth Wisely?

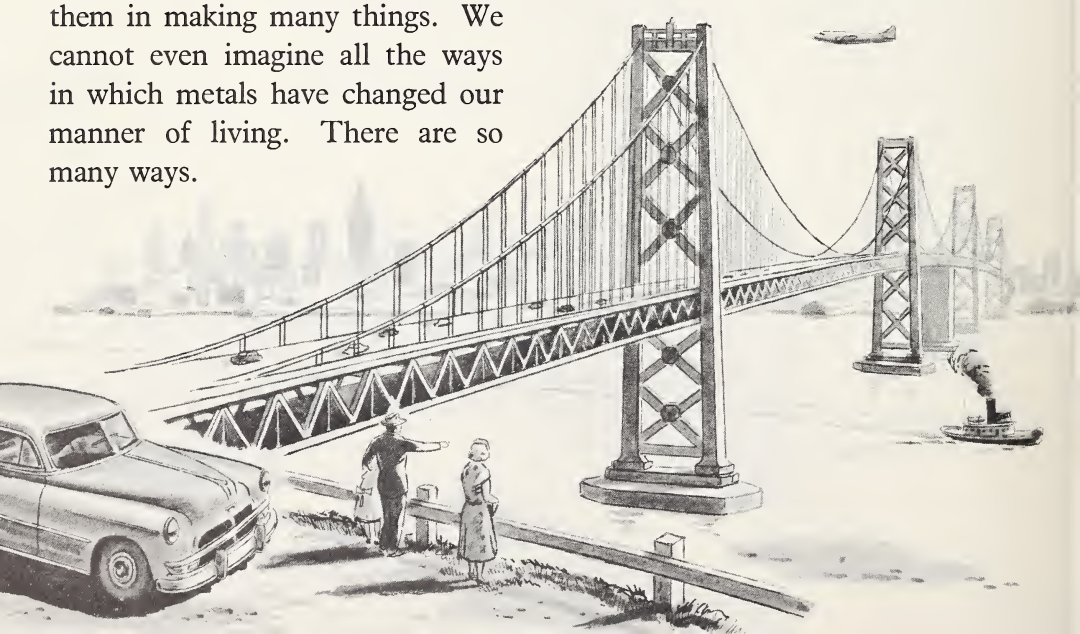
Many hundreds of years ago men made a very important discovery. They learned to obtain metals from the ground. Rock, sand, or dirt from which metal is obtained is called ore.

Copper was one of the earliest metals discovered. It changed early man's way of living a great deal. Now tools and weapons could be made of strong copper instead of wood or stone. These copper tools and weapons were better. Man moved ahead in his ways of living.

Today copper, iron, aluminum, and magnesium are some of our very important metals. We use them in making many things. We cannot even imagine all the ways in which metals have changed our manner of living. There are so many ways.

Iron is a useful metal in itself, and it is even more useful because steel is made from it. Strong frames for skyscrapers are made of steel. Long steel bridges stretch across big rivers. Part of your car is made of steel. The nails, screws, and bolts that hold many things together are made of either iron or steel. Farm tools and machines have iron and steel in them, too.

Many cooking dishes are made of iron or steel. What about your pancake griddle? What about your frying pan? Are they made of iron? Perhaps they are made of aluminum or of copper.



Useful metal products

Copper is used in many ways today. The pipes in your house may be copper pipes. Copper does not rust easily when water gets near it. The boiler for heating your water may be copper.

Electric wires may be copper. Kettles and tanks of many kinds are made of copper. It is used in hundreds of ways.

Aluminum is also a very useful metal. It is light in weight, but very, very strong. That is why airplane factories make so much use of aluminum. An iron airplane would be much too heavy to fly.

Aluminum does not rust easily. It is often used instead of iron for water pipes. Aluminum wire is sometimes used in electric circuits instead of copper wire. Aluminum is a good conductor of electricity.

Magnesium is a very strong and light metal. Much of what we have is taken from sea water. It has many uses.

Many airplanes now are made of magnesium instead of aluminum. Your camera flash bulb, which you use to take a picture, burns magnesium. Flares dropped from airplanes burn magnesium because it gives such a brilliant flash of light, which may be seen for miles.

Tin is another metal that man uses in many ways. It is really a rare metal, not found in many places in the earth. Much food is stored in tin cans. These cans are really made of iron. But they are covered with a thin coating of tin. The tin keeps the iron from rusting and in that way helps to preserve the canned food.

How well have we used these important metals? Surely we cannot afford to waste them.

But do we? Is it a waste of iron and steel to pile car after car in junk heaps and let them rust? Is it a waste of metal to throw can after can away with the rubbish? Could we use these metals again?

The answer is yes. Tin and scrap iron can be melted and used again. They should be saved and put to good use.

Unless we do save scrap iron and use it over again, we may someday run out of iron. Then where shall we be? How then shall we build new ships and bridges and cars and skyscrapers?

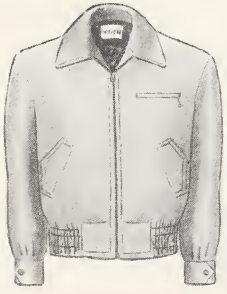
Using metal wisely is worth thinking about. Save some of it for tomorrow!

You may be one of those people who say, "Why worry? Someone will come along and invent a new way to make cars and bridges and skyscrapers."

That may be true. We now have nylon, which is used to make many things once made of silk. We now have synthetic rubber, which is used to make many objects once made of real rubber. Plastics have replaced many products. And these plastic products are excellent.

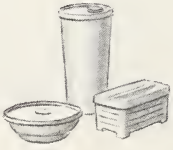
But as yet we have no good ways to replace strong steel in buildings. We have as yet no plastic to replace aluminum and magnesium in airplanes. We have no plastic to replace many useful metals.

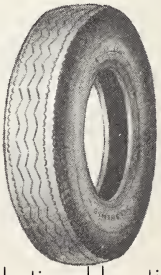
Someday we may have such substitutes. Perhaps within the next few years we may. But until then it would seem to be good sense to use wisely the metals we have. Be sure you help.



Nylon jacket

Plastic dishes





Synthetic-rubber tire

THINGS TO THINK ABOUT AND DO

1. Perhaps you think you can do nothing about using materials wisely. Perhaps you think grownups are the only people who have to think about such things.

But wait a minute! How about wasting food? When you waste food, don't you really waste minerals? It was the minerals in soil that made your food grow.

What about wasting paper? When you waste it, aren't you also wasting minerals? Minerals in the soil were used to grow the trees that make some of the paper you use.

What about leaving your metal wagon, skates, or bicycle out night after night? Do they rust? Rust will soon ruin things that are made of metal. Many of your toys are made of iron. You can make them last longer by taking good care of them. Keep them dry, and they will not rust so quickly.

What about burning leaves? When you do that, aren't you wasting minerals? The materials in leaves should be put back into the soil to keep it good.

When you leave the garden hose running longer than you need to, aren't you wasting materials? You are wasting the minerals that are in water. Some of these minerals run off down the gutter as the water is wasted. Using materials wisely is the business of grownups. But it is your business, too.

2. Do you live near a place where any minerals are made into products that you use every day? If so, perhaps you could visit this place and find out how these products are made.

3. You may wish to share your interest in using materials wisely. You may wish to have an assembly program and tell others in your school about some of the ways everyone can help in this matter. Be sure to tell them that they can help by using paper, food, and water wisely.

4. You are living in a very interesting time. Think of the things that are happening today. New plastics are being made to take the place of products that were once made of metals. Better ways of mining are being used all the time. Someday we may get many more minerals from the ocean.

Scientists are finding better and better methods of working with many materials. Doctors are learning how to use many minerals to keep you well. Dentists are using minerals to keep your teeth in good condition. Can you think of any inventions and discoveries that may come soon?

5. The story of how coal was formed is an interesting one. Perhaps someone in your class would like to give a report about it.

6. You might like to find out all you can about minerals in the sea. Try to find out as much as you can about how scientists are working to get these materials. Read about some of the reasons why it is so difficult to recover the minerals that are in the sea.

Science Words

This part of your book is a science dictionary. It will help you find the meanings of words which are used in your book. The page number following each word shows you on what page the word is first found.

ab do'men. The third section of an insect's body. The first two sections are the head and thorax (p. 149).

air. A mixture of gases that we breathe. We live at the bottom of an ocean of air (p. 13).

air pres'sure. The weight with which air presses upon things. Air presses upon everything on the earth, including people (p. 92).

a moe'ba. A tiny, one-celled animal. One of the simplest forms of animal life (p. 146).

am phib'i an. An animal that lives the early part of its life in water and breathes with gills. Later it develops lungs (p. 156).

an'nu al. A plant that lives only one year (p. 45).

a qua'ri um. A tank or bowl of water in which living plants and animals are kept (p. 60).

as'phalt. A brownish-colored material produced from petroleum and also from coal tar (p. 244).

at'mos phere. The layer of gases around the land-and-water part of the earth (p. 78).

bi en'ni al. A plant that lives two years (p. 46).

birds. A group of animals that are covered with feathers (p. 21).

bud. A part of a plant which can develop into flowers, leaves, stems, or roots (p. 42).

bulb. An underground stem. Onions and tulips grow bulbs. Bulbs can grow into new plants (p. 37).

cac'tus. A plant that grows in hot, dry desert places (p. 52).

cal'ci um. A mineral that builds strong bones and bodies (p. 233).

car'bon. A material that is part of living or dead plants and animals. Coal is mostly carbon (p. 167).

car'bon di ox'ide. One of the gases found in air (p. 103).

cas'es. Hard coverings of some plants and animals. Moths and butterflies make cases around themselves. They change inside these cases. Spores develop inside cases, too (p. 140).

cen'tu ry. One hundred years (p. 226).

chem'i cal. All material is made up of chemicals. Air, food, and rocks are mixtures of chemicals (p. 167).

cir'cuit. A path along which electricity can travel (p. 168).

cold-blood'ed an'i mal. An animal whose blood is about the same tem-

perature as the air or water around it (p. 154).

con duc'tor. Any material through which vibrations or electricity pass easily (p. 123).

con glom'er ate. A rock made up of pebbles cemented together (p. 229).

con'stant-tem'per a tured an'i mal. An animal whose blood remains about the same temperature all the time. A warm-blooded animal is a constant-temperatured animal (p. 159).

cor'al. A small sea animal which builds a hard skeleton around its soft body (p. 186).

crys'tals. Material having a definite structure. Minerals form crystals (p. 212).

cur'rent. A flowing, or moving forward. An electric current flows through wire (p. 101).

cut'ting. A part cut from a plant. Roots and leaves will grow from a cutting (p. 138).

des'ert. Any part of the earth where there is not enough water for many plants to grow well (p. 52).

dis solve'. To become part of a liquid. Sugar dissolves in water (p. 212).

dry cell. Chemicals in a sealed container which will produce electricity (p. 166).

ear'drum. A thin membrane that stretches across the middle ear. This membrane makes hearing possible (p. 111).

earth'quake. Trembling, or shaking, of the ground caused by movements of the rocks near the surface of the earth (p. 83).

e lec tric'i ty. A form of energy. Electricity can do work (p. 164).

e lec tro mag'net. A magnet made by winding insulated wire around a piece of soft iron. The soft iron becomes a magnet when electricity goes through the wire (p. 176).

e qua'tor. An imaginary line around the earth halfway between the north and south poles (p. 7).

e rupt'. To burst forth. A volcano and a geyser erupt (p. 81).

e vap'o rate. To change into a gas. Water evaporates into the air (p. 52).

ex pand'. To get larger (p. 94).

ex per'i ment. A trial made to prove or disprove something (p. 9).

eyes. Buds on a white potato. New plants grow from these buds (p. 137).

feel'ers. The organs of touch of some animals. Feelers of insects stick out from their heads (p. 150).

feld'spar. A common mineral (p. 216).

fer'ti liz er. Material that is put on soil to improve it (p. 38).

fish hatch'er y. A place where fish eggs are hatched and fish are grown until they are large enough for use in stocking streams (p. 207).

flow'er. The part of a plant from which seeds form (p. 41).

force. A push or pull that tends to start objects moving (p. 92).

fruit. A seed and the materials that grow around it (p. 43).

gas. A material that does not fill a

definite space. Air is a mixture of gases (p. 80).

gill. A part of some water animals. By means of gills oxygen is taken from the water (p. 153).

graft'ing. Putting a slip, or cutting, of one plant into a cut on the stem of another plant (p. 139).

gran'ite. A common rock that has been formed by heat. It usually has feldspar, quartz, and mica in it (p. 224).

hi'ber nate. To appear to sleep during the cold weather. Animals become quiet when they hibernate (p. 22).

horn'blende. A dark-colored mineral. Hornblende is often found in granite (p. 224).

ig'ne ous rock. Fire-made rock (p. 221).

in'sect. An animal with three body parts and six legs (p. 21).

in'su la tor. A material through which electricity will not pass easily (p. 173).

ir'ri ga tion. Watering the land (p. 37).

lime'stone. One kind of sedimentary rock. It is made from shells and bones of animals or from lime in water (p. 189).

liq'uid. A material that has no definite shape. Milk, water, and gasoline are liquids (p. 125).

lung. The part of people and of many animals that takes oxygen from the air as they breathe (p. 103).

mag'ma. Liquid, or molten, rock under the surface of the ground (p. 82).

mag ne'si um. A silver-white, very lightweight metal (p. 201).

mag'net. A piece of iron or steel or other material that attracts other pieces of iron or steel (p. 176).

mam'mal. A warm-blooded animal that has a backbone and hair or fur. A mother mammal feeds its young with milk from its own body (p. 160).

mem'brane. A thin sheet of skinlike tissue. The eardrum is a membrane (p. 111).

met'al. A mineral that is a conductor of electricity. Aluminum, iron, and copper are metals (p. 121).

met a mor'phic rock. Made-over, or changed, rock. Marble and gneiss are metamorphic rocks (p. 231).

mi'ca. One of the minerals often found in granite. It is a shiny mineral (p. 217).

mi'cro scope. An instrument that makes any small object look bigger (p. 140).

mi'grate. To travel at regular times from one place to another and back again (p. 25).

mil'dew. A small plant that grows from spores. Mildew may grow on damp clothes (p. 141).

min'er al. Almost any material in the earth. Quartz and feldspar are minerals. Some minerals are dissolved in water (p. 200).

mold. A tiny plant that may grow on old or damp plant and animal material. Mold sometimes grows on stale bread (p. 141).

mol'ten. Melted by heat. Rocks can be heated to a molten, or liquid, state (p. 221).

naph'tha. A product of petroleum often used in cleaning (p. 246).

oil re fin'er y. A place where many products are made from crude oil (p. 246).

ooze. The material on the floor of the deep ocean. It is made of remains of plants and animals, pebbles and volcanic ash (p. 189).

ox'y gen. A colorless gas that makes up part of the air (p. 88).

per en'ni al. A plant that lives more than two years. Trees are perennials (p. 44).

pe tro'le um. A thick, dark-colored liquid that forms inside the earth (p. 245).

pitch. The highness or lowness of a sound. It is caused by the vibration of an object (p. 113).

plank'ton. The tiny, living plants and animals that float on or near the surface of water. Many water animals feed on plankton (p. 187).

plas'tics. Man-made materials that can easily be made into different forms. Nylon is a plastic. Cloth, bristles, and toothbrush handles are made of nylon (p. 173).

pol lut'ed. Unclean. Polluted water is not safe for most living things (p. 206).

pum'ice. A volcanic rock (p. 224).

quartz. A hard, shiny mineral found in many rocks. Granite usually has quartz in it (p. 216).

queen bee. The mother bee (p. 31).

rep'tile. A cold-blooded animal with scales or a scalelike covering. A reptile breathes with lungs all its life (p. 155).

res'er voir. A storage place for water (p. 37).

re volve'. To turn around another object. The earth revolves around the sun (p. 77).

ro'tate. To turn around on itself. The earth rotates once every twenty-four hours (p. 77).

run'ner. A slender branch that grows out over the surface of the ground from a parent plant. A new plant may grow at the end of or at joints on a runner (p. 138).

sand'stone. A kind of rock formed under water or by wind deposits. It is made of sand (p. 228).

sap. The watery juice of a plant (p. 39).

scales. Thin, flat pieces of material that fit over one another to form the covering of most reptiles and fishes (p. 154).

sci'en tist. A person who has studied science carefully for a long time (p. 68).

sea a nem'o ne. A small water animal that looks more like a plant than an animal (p. 192).

sea'son. One of the parts into which a year is divided. Summer is one of the seasons of the year (p. 4).

sea'weed. Any one of many plants that grow in the sea (p. 60).

sed i men'ta ry rock. Rocks made from material, or sediment, dropped by wind or water (p. 226).

seis'mo graph. An instrument that records earthquakes (p. 83).

sep a ra'tion lay'er. A layer of cork that forms at the place where the stem of a leaf joins the twig (p. 39).

sew'age. Waste material of all kinds, carried off through a sewer (p. 209).

short cir'cuit. An accidental touching together of two bare wires causing an electrical current to take a shorter path than it would otherwise have taken (p. 175).

skel'e ton. The bones or hard covering of an animal (p. 152).

soil. The top layer of ground (p. 38).

sol'id. Any material that keeps its shape (p. 125).

sound. Vibrations heard through the ear (p. 106).

spines. Sharp growths on plants or animals. Many cacti have spines (p. 52).

spore. A tiny part of certain kinds of plants from which new plants form. Ferns grow from spores instead of seeds (p. 140).

star'fish. A spiny-skinned, many-armed, sea animal. Most have five arms (p. 147).

sto'lon. A runner, or branch, of a plant that takes root at the tip or at joints and forms new plants. Strawberry plants grow from stolons (p. 138).

tem'per a ture. The measure of the heat of anything (p. 6).

ter rar'i um. A tank or glass dish in which living plants and animals are kept (p. 47).

ther mom'e ter. An instrument that measures heat (p. 58).

tho'rax. The middle section of an insect's body (p. 149).

top'soil. The layer of soil at the surface of the earth. Plants grow in this layer (p. 237).

var'i a ble tem'per a tured an'i mal. An animal whose blood changes temperature with its surroundings (p. 154).

vein. A part of a leaf which holds tubes that carry liquids (p. 143).

vi'brate. To move back and forth rapidly (p. 108).

vol ca'no. A mountain that sometimes shoots out melted rocks and gases (p. 78).

warm-blood'ed an'i mal. An animal whose body temperature is about the same all the time (p. 158).

work'er bee. One of the bees in a hive. Workers do most of the work of the hive (p. 31).

zinc. A bluish-white metal. Zinc is used to make the can of a dry cell (p. 166).

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